The Australian and New Zealand Journal of Surgery

OCTOBER, 1945.

TABLE OF CONTENTS.

[The Whole of the Literary Matter in THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY is Copyright.]

ORIGINAL ARTICLES— PAGE

Surgical Problems in the Later Stages of Penetrating Head Injuries *Murray A. Falconer* 75

Ectopia Vesicæ ..... *H. P. and C. M. Pickerill* 91

The Place of Surgery in the Treatment of Pulmonary Tuberculosis *C. J. Officer Brown* 99

A Comparison of the Tensile Strengths of Iodine Sterilized and Heat Sterilized Catgut Sutures ..... *P. M. Rountree* 118

CASE REPORTS—

An Osteotomy to Correct Right-Angle Deformity ..... *J. Hoets* 123

Parathyreoid Tumour: Report of a Case and Surgical Discussion *H. R. G. Poate and A. C. Christie* 124

Extensive Airscrew Injuries of the Skull and Brain with Recovery of the Patient ..... *T. F. Rose* 133

SURGERY IN OTHER COUNTRIES—

Conservatism in the Treatment of Acute Osteomyelitis of the Long Bones 138

Voluntary Subluxation of the Hip in Children 138

The Conservative Treatment of Impermeable Œsophageal Stricture 139

Treatment of "Raised Humerus" 140

REVIEWS—

The Student's Pocket Prescriber and Guide to Prescription Writing 141

Pye's Surgical Handicraft 141

Illustrations of Bandaging and First Aid 141

The Urinary Tract: A Handbook of Roentgen Diagnosis 141

Handbook of Practical Bacteriology 142

Bone-Grafting in the Treatment of Fractures 142

Pulmonary Tuberculosis: A Handbook for Students and Practitioners 143

The Neurosurgical Patient: His Problems of Diagnosis and Care 144

Royal College of Surgeons of England.

JACKSONIAN PRIZE.

THE Council of the Royal Australasian College of Surgeons has been advised by the Council of the Royal College of Surgeons of England that the subject chosen for the Jacksonian Prize for the year 1946 is "Traumatic Aneurysm". Full details governing the conditions of the prize may be obtained from the Secretary of the Royal Australasian College of Surgeons, Spring Street, Melbourne, C.1.

The International Society of Surgery.

THE activities of the International Society of Surgery have necessarily been largely in abeyance during the war years, but now that hostilities have come to an end there are promising signs of resuscitation. At the time of the meeting of the Association of Surgeons held at the Royal College of Surgeons in May there was an informal gathering of those British members of the International Society who happened to be in London at that time. They were very glad to welcome Dr. Leopold Mayer, of Brussels, the President-elect of the International Society of Surgery, together with other Belgian and American members who were guests at the meeting of the Association. The steps taken by the American Committee with the intention of holding the Society together in that country during the war years were explained. It was recognized by the members that anything that had been done was only a temporary war measure designed to keep the Society alive and its interests revived. It is intended to hold a meeting of the International Committee as soon as this can be arranged. There is some hope that the full meeting of the Society, which was originally planned to take place in Stockholm in 1941, may be held in that city in 1947. Meanwhile, the surviving officers who were elected at the congress held in Brussels in 1938 will continue to act and conduct the affairs of the Society strictly according to the constitution. Professor Grey Turner continues as the British delegate on the International Committee.

Editorial Notices.

ALL articles submitted for publication in this journal must be typewritten and double or treble spacing should be used. Each article should conclude with a brief summary and statement of conclusions. Authors are requested to avoid the use of abbreviations and not to underline either words or phrases.

Authors are requested to submit two typescript copies of all articles.

References to articles and books should be carefully checked. In a reference the following information should be given without any abbreviation: initials of author, surname of author, full title of article, name of journal, volume, full date (month, day and year), number of the first page of the article. If a reference is made to an abstract of a paper, the name of the original journal, together with that of the journal in which the abstract has appeared, should be given, with full date in each instance.

When illustrations are required, good photographic prints on glossy gaslight paper should be submitted. Line drawings, charts, graphs and so forth should be drawn on thick white paper in indian ink. Authors who are not accustomed to prepare drawings of this kind, are invited to seek the advice of the Editor if they are in any doubt as to the correct procedure. Skiagrams can be reproduced satisfactorily only if good prints or negatives are available.

Editorial communications should be addressed to the Secretary of the Royal Australasian College of Surgeons, Spring Street, Melbourne, C.1. It is understood that original articles forwarded for publication are offered to THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY solely, unless the contrary be stated.

Reprints can be supplied at cost price; the minimum number is fifty copies. Orders for reprints must be given when the proof is returned.

Exchange journals should be addressed to the Honorary Librarian, Royal Australasian College of Surgeons, Spring Street, Melbourne, C.1, Victoria, Australia.

Business communications and remittances should be addressed to Butterworth and Co. (Australia) Ltd., 6-8 O'Connell Street, Sydney.

The announcements appearing in this journal contribute largely towards the maintenance of the high standard of the publication. It is, therefore, requested that, wherever possible, readers will support the business houses whose advertisements appear in the journal and that, when placing their orders, they will mention THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY.

THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY

Registered at the General Post Office, Melbourne, for transmission by post as a periodical.

VOL. XV. OCTOBER, 1945. No. 2.

SURGICAL PROBLEMS IN THE LATER STAGES OF PENETRATING HEAD INJURIES.[1]

By MURRAY A. FALCONER,

Lecturer in Neurosurgery, Otago University; Consultant in Neurosurgery, New Zealand Military Forces.

MY part in today's discussion is to consider the surgical problems which may arise in the later stages following penetrating wounds of the brain. My remarks will be concerned principally with cases of gunshot wound, but many cases of penetrating injury caused by depressed skull fractures of a more civilian character present similar therapeutic problems.

Of course most patients with penetrating injury of the brain, if properly and adequately handled in the initial stages, should not require further operative treatment.[(1)] Fortunately many of them are left with little or no permanent neurological disability, and in due course make a good functional recovery. Those who do have some permanent neurological disturbance, such as a hemiparesis, a cortical sensory defect, an aphasia, or a hemianopsia, may require extensive reeducation and training at the hands of a physiotherapist or an educationist; and it is surprising how well many of them learn to overcome their disabilities and to lead useful lives again, although perhaps at a lower level of activity than formerly. Even after the severest degrees of motor paralysis from cortical injury, patients will usually learn to walk again, particularly when assisted by a suitable walking caliper with toe-lifting spring to correct foot-drop.

A few patients, however, exhibit features which can be benefited by further operation. It therefore behoves us as surgeons to know the indications for late-stage operative treatment, and the results. The problems most likely to be encountered can be dealt with under four headings, as follows: (*a*) the indications for the removal of retained foreign bodies; (*b*) the indications for the repair of skull defects; (*c*) the treatment of recurrent and delayed cerebral abscesses; (*d*) the indications for the excision of brain scars.

THE REMOVAL OF RETAINED FOREIGN BODIES.

The chief risks of indriven foreign bodies are, of course, epilepsy and abscess formation. Few retained foreign bodies, whether metallic or bony, are likely to cause these complications unless they are actually lodged in the cortex or are already infected. If an adequate operation has been performed shortly after infliction of the wound, such foreign bodies will have been

[1] Read at a discussion on penetrating head injuries held at Auckland by the New Zealand Branch of the Royal Australasian College of Surgeons on August 31, 1944, and illustrated by lantern slides. Accepted for publication on May 7, 1945.

removed."[1] Metallic fragments from projectiles are sterilized by the heat of the explosion, and those that penetrate deeply into the white matter usually remain silent. Deeply situated metallic bodies, therefore, are best left alone unless they become implicated in a brain abscess.

Once the original wound has healed, it is folly to attempt to remove a retained foreign body at a secondary operation, unless it is actually causing

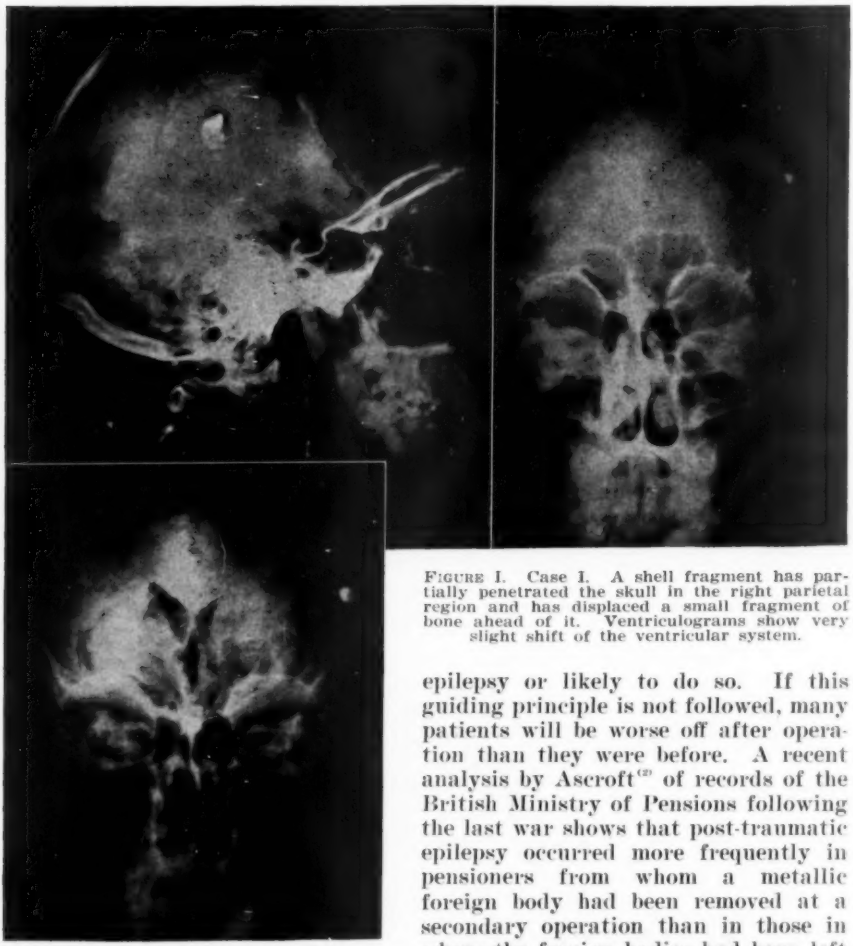


FIGURE I. Case 1. A shell fragment has partially penetrated the skull in the right parietal region and has displaced a small fragment of bone ahead of it. Ventriculograms show very slight shift of the ventricular system.

epilepsy or likely to do so. If this guiding principle is not followed, many patients will be worse off after operation than they were before. A recent analysis by Ascroft[2] of records of the British Ministry of Pensions following the last war shows that post-traumatic epilepsy occurred more frequently in pensioners from whom a metallic foreign body had been removed at a secondary operation than in those in whom the foreign bodies had been left undisturbed. The incidence was 53% in the first group, as opposed to 38% in the second group. The reason for the disparity between these two groups is undoubtedly the additional trauma, which was so frequently inflicted upon the brain by ill-judged attempts at removal. These statistics, however, should not deter us from recommending operation in properly selected cases, for it is well known that in the right type of case benefit can often be conferred by careful removal of a foreign body. The selection of cases is a matter for discrimination, and the principles involved are well illustrated by the following four histories.

CASE I.—*Example of a Superficially Situated Foreign Body Causing Symptoms and Removed at an Early Stage.* A soldier was wounded in the right parietal region by a shell fragment. At the time he thought his head was merely scratched, and he continued on duty. However, six weeks later, he came under my care at a British military hospital for head injuries because of frequently recurring major epileptic attacks, each of which commenced with twitching movements of the left side of the face. X rays revealed a small metallic fragment which had just penetrated the skull in the region of the face area of the motor cortex and had displaced a small

A Twitching left side of mouth
B Twitching left eyelids.
C Twitching left arm
D Twitching left arm
E Silent
F Stiffening of left arm, muffled voice

FIGURE II. Operative findings in Case I. Top inset shows siting of scalp and bone flaps in relation to skull defect. Left, the appearances after reflection of the bone flap; the metallic fragment has partially penetrated the dura. Right, the appearances after reflection of the dura; the foreign body has invaginated the brain immediately behind the excitable motor cortex, which has been mapped out by a thyratron stimulator. Bottom inset shows an intact cortical vessel coursing beneath the foreign bodies, as revealed during their removal.

fragment of bone ahead of it (Figure I). These two foreign bodies, metallic and bony in conjunction, were clearly acting as the exciting agent in the epileptic attacks, and as they were readily accessible, their operative removal was advised. They were exposed by the turning of a craniotomy flap (Figure II), and not by a mere trephine hole, which would only have allowed of blind manipulations. A point of interest is that we found the cortex had been merely indented and not penetrated, for a cortical vein which ran beneath the foreign bodies was still intact. The depressed cortex was not obviously damaged and therefore was not excised. In closing the craniotomy wound after the foreign bodies had been removed, the cortex was covered with a piece of prepared amniotic membrane to minimize the formation of adhesions, while the defect in the dura was repaired with a piece of temporal fascia. The patient made an excellent recovery.

CASE II.—*Example of a Superficially Situated Foreign Body Causing Symptoms and Removed at a Late Stage.* This patient, a pensioner, aged fifty-two years, suffered from chronic post-traumatic epilepsy associated with a retained metallic foreign body. He had been wounded at Gallipoli by a revolver bullet in the right frontal region (Figure III), and after an interval of three years had developed attacks of *grand mal*,

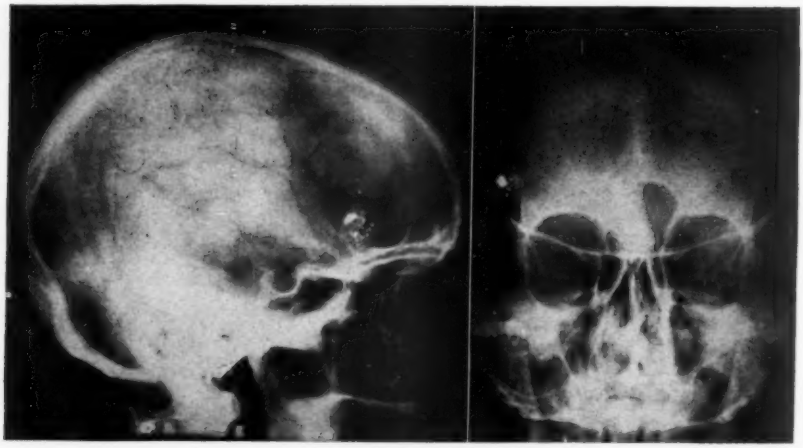


FIGURE III. Case II. A revolver bullet has just penetrated the skull in the lower right frontal region and is lodged in the cortex.

FIGURE IV. Case IV. Several pieces of shrapnel have penetrated the skull in the left frontal region. One is recognizable as a screw. They are all silent and their removal is not indicated.

which had steadily increased in frequency and were not controlled by standard sedative drugs. Twenty-five years later an exposure similar to that in the preceding case was carried out at the Dunedin Hospital. This time, however, the metallic foreign body was firmly lodged in the cortex, and it was surrounded by a zone of scarred brain tissue. Consequently it was necessary to excise a block of the scarred brain tissue with the foreign body at its centre. Following operation the frequency of epileptic attacks was lessened.

CASE III.—*Example of a Deeply Situated Metallic Foreign Body, the Removal of which was not Indicated.* This war pensioner came exclaiming "What do you think of the screw in my head, doctor?" (Figure IV). He had been wounded by shrapnel three years earlier, and after some initial delay he had made a satisfactory recovery. His forehead wound was soundly healed, his intellectual faculties appeared normal, and neurological examination revealed no abnormality. He had not had fits. The unusual nature of the retained piece of metal had attracted attention, and his friends were repeatedly advising him to have it out. It was, however, symptomless, as were the many other fragments scattered throughout his brain. After explanation the patient felt reassured.

CASE IV.—*Another Example of a Deeply Situated Metallic Fragment, the Removal of which was not Indicated.* This is another example of a case in which removal of the metallic foreign body was unwarranted. The patient had been wounded in the left temporal region eighteen months previously. At the time the wound had been regarded as trivial and had healed promptly, but, starting five months later, he had

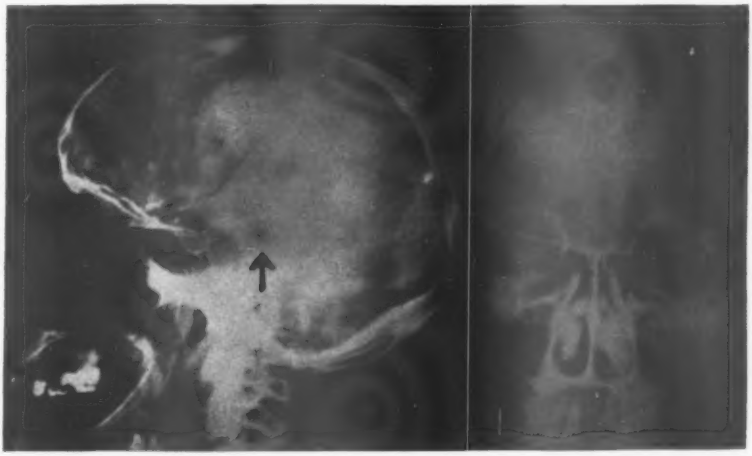


FIGURE V. Case IV. A metallic fragment has penetrated the skull in the left temporal region at the point marked with an arrow and has lodged in the left occipital lobe. The epileptogenic focus lay beneath the point of entry and not around the foreign body.

developed periodic attacks of *grand mal*, each of which began with twitching movements of the right eyelid. X-ray examination revealed a retained metallic foreign body (Figure V), which a medical board advised should be removed. Scrutiny of the radiographs, however, showed, in addition to the metallic body, located deep in the occipital lobe, a puncture of the skull in the temporal region, with a small depressed fragment of bone beneath it. Furthermore, neurological examination disclosed a partial right-sided, upper-quadrantic, homonymous hemianopia as the only positive finding. It was evident from the nature of the epileptic aura, when taken in conjunction with the localizing significance of the single neurological sign, that the epileptogenic focus was situated not in the vicinity of the metallic body, but in the scarred cortex beneath the skull defect. I therefore advised against operative removal of the piece of metal, as, like most buried metallic fragments, it was not causing symptoms. But before recommending operative excision of the cicatrix beneath the skull puncture, I advised a period of proper medical care with phenobarbitone. A year later his family doctor reported he was now completely free of attacks and had never felt better in his life.

This last case illustrates well two lessons. The first is that foreign bodies, unless actually lodged in the cortex, do not of themselves cause epilepsy, and consequently need not be disturbed (unless of course they are associated with an inflammatory lesion). The second lesson, the paramount importance of an adequate trial of medical treatment before excising a brain scar, will be considered later.

REPAIR OF SKULL DEFECTS.

The chief reason for repairing a skull defect is to protect the underlying brain and prevent further injury. Cosmetic and psychological reasons should be secondary considerations. Not every skull defect requires repair, for in many, and especially in most of the smaller ones, the brain is reasonably well protected by a firm dural barrier. When, however, there is also an associated dural deficiency, operative repair is usually advisable. Defects of this type are characterized by bulging of the brain through the skull aperture on

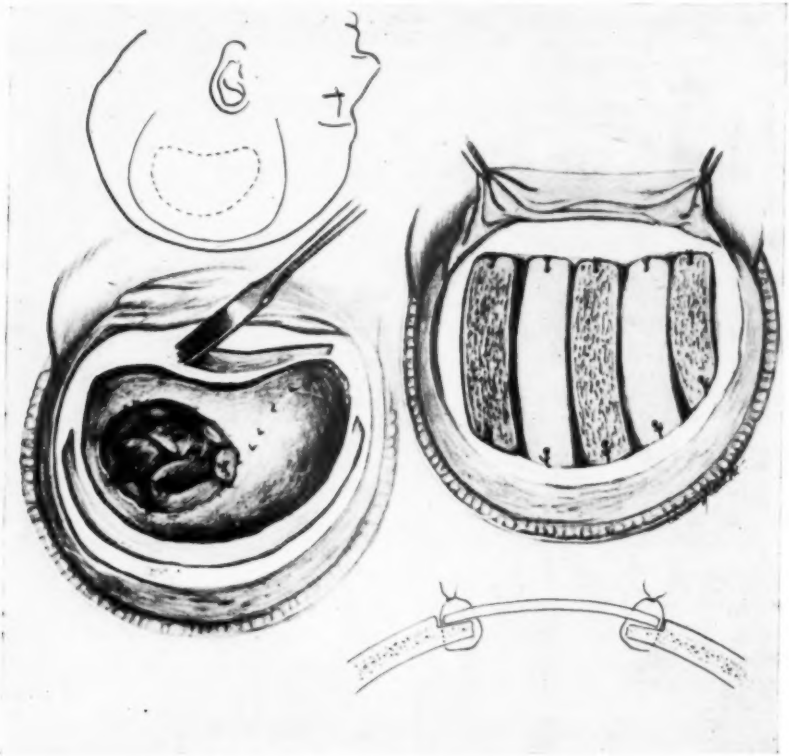


FIGURE VI. Repair of skull defect by split-rib grafts. Top inset shows siting of scalp flap in relation to bone defect. Left, the skull defect as exposed by reflection of scalp flap and incision of pericranium; a step is being cut to receive the grafts. Right, the grafts have been laid in position. Bottom inset shows the method of anchoring the grafts.

coughing, straining, or stooping, or other conditions in which the intracranial pressure is raised; but when the patient is erect the brain becomes indrawn. The constant to-and-fro movement of the brain at the hernial orifice is a potent epileptogenic stimulus, and its correction is often followed by cessation or lessening of epileptic attacks. It can also result in certain circumstances in the formation of a porencephalic cyst.[3]

Now there are many ways of repairing skull defects. Some are more satisfactory than others. A good method is one which can readily be applied to defects of varying sizes and contours, requires no elaborate apparatus or complicated technique, has a short convalescence, and does not leave behind

materials which are likely to cause later trouble or excite an undesirable reaction in the underlying brain. The method which in my experience best fulfils these criteria is that employing split-rib grafts, a method first advocated by Grant and Norcross.[40]

Figure VI illustrates the method. A scalp flap is reflected, the incision encircling the defect and keeping outside the pericranium. Next, the pericranium is incised along the edges of the defect and its margins are thus defined. Then a step is chiselled on either side of the defect to receive the grafts, which are segments of a rib split longitudinally, each segment being inlaid with its convex surface outwards. Those grafts which are taken from the inner half of the split rib of course present a cancellous surface outwards, while the others present a smooth outer surface. Either silk or fine wire may be used to fix the grafts in position, and the necessary holes in the skull and the grafts can be quickly made with a Cone's skull punch. Such rib grafts make a compact covering for the skull defect (Figure VII), and in the course of time they become firmly incorporated into the skull. Another important advantage over other types of autogenous bone graft is that not only are they more malleable, but they already possess an intrinsic curvature which is similar to that of the contours of the skull. They are very useful, for example, in reproducing such features as the curve of the temporal crest (Figure VIII).

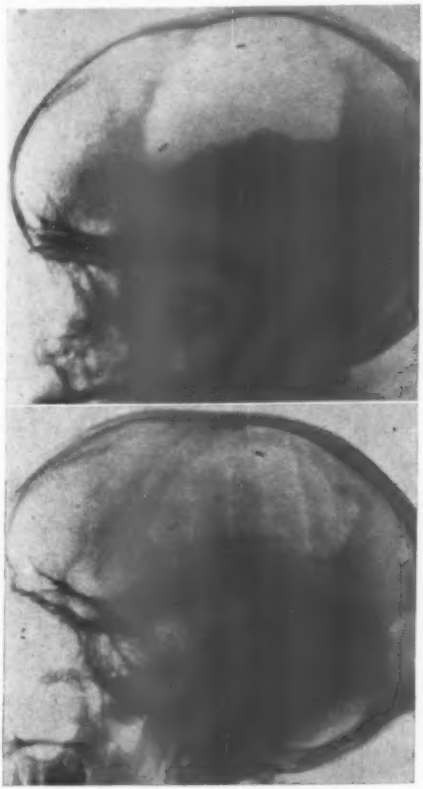


FIGURE VII. Radiographs of case illustrated in Figure VI before and after operation to show position of grafts. The two silver clips were placed on bleeding cortical vessels at the original operation shortly after the patient was wounded.

TREATMENT OF RECURRENT AND DELAYED CEREBRAL ABSCESSES.

It cannot be stressed too strongly that in all cases in which a cerebral abscess has been drained or at any stage suspected, the patient should afterwards be watched with great care. This is because an occasional brain abscess, which has been drained with apparent success, will later flare up once more. Moreover, in a few cases a brain abscess may not show up until months or years have elapsed after the wound was received, although in the majority of cases, of course, symptoms appear early. I have had the bitter experience of learning that at least two of the patients with infected skull wounds, whom I encountered following Dunkirk, had later died in circumstances indicating a terminal meningitis. This had occurred in spite of the fact that the indriven bony and metallic fragments at the site of the entry wound had been removed apparently satisfactorily at a secondary operation one to two weeks after the

patients were wounded. In one case, in which the patient died two years after being wounded, an autopsy revealed a small chronic abscess which had ruptured into the lateral ventricle. This man had complained intermittently of headaches for which he had even been investigated by encephalography,

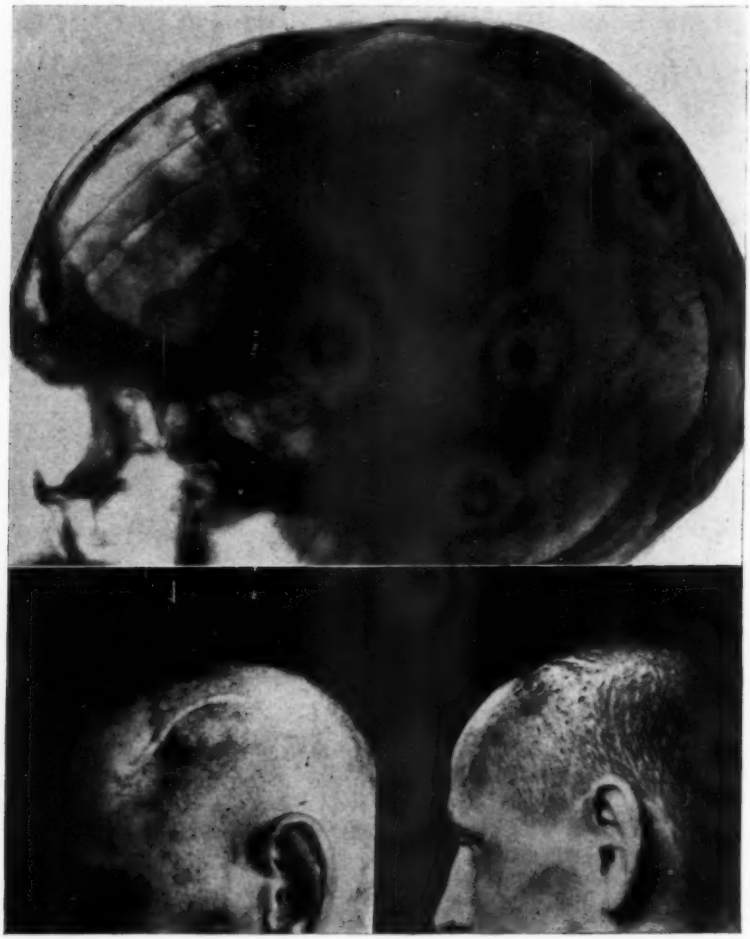


FIGURE VIII. Reconstruction of the temporal crest by split-rib grafts. Top, radiograph showing grafts in position. Bottom, the surface appearances before and after operation.

but as the ventricular outlines showed no distortion we had dismissed the possibility of abscess, a mistake in judgement which further experience corrected for us.

The following histories give other examples of delayed and recurrent brain abscesses.

CASE V.—*Example of a Brain Abscess in which Symptoms were Delayed for Six Months.* This sailor had been wounded in the right frontal region during a naval engagement and at operation a day later a number of depressed and indriven

bony fragments were removed. His wound healed quickly and in due course he was sent to a convalescent home. At times he complained of headache, but he seemed to get over each attack fairly well. However, six months after being wounded he developed over the course of ten days or so severe headaches and vomiting, became drowsy, and showed signs of raised intracranial pressure. He was transferred to a military hospital for head injuries as a suspected sufferer from brain abscess. When a lumbar puncture needle was inserted through the healed skull defect, pus was located in the frontal lobe, and after fifty cubic centimetres had been aspirated, two cubic centimetres of "Thorotrast" were injected and the abscess cavity was then demonstrated in radiographs (Figure IX). Thereafter the abscess was reaspirated about once a week for two months, by which time its cavity had become shrunken with wrinkled walls, indicating advanced fibrous encapsulation. (Incidentally, Figure IX also shows that a sizeable chronic abscess may exist without any shift or local indentation of the lateral ventricles, a point which we had not realized in 1940, when dealing with casualties from Dunkirk.) Finally, I turned a craniotomy flap and excised this encapsulated abscess intact as if it were a tumour, thereby completely ridding the patient of his intracranial infection.

CASE VI.—*Example of a Brain Abscess in which Symptoms were Delayed for More than Five Years.* A lad, aged sixteen years, was accidentally wounded by a 0·22 rifle bullet, which penetrated the skull in the left parietal region and came to lodge in the left frontal lobe. X-ray examination showed that the bullet had shattered, leaving several fragments scattered along its track (Figure X). He was seriously ill for many months but eventually he recovered to the extent of taking up work as a sign-writer, although he had a slight residual right-sided hemiparesis and a speech defect. Subsequently he had many major epileptic attacks in which the convulsive movements involved chiefly the right limbs. Then more than five years after being wounded he started to complain of headaches. Three weeks later, when admitted to hospital, he was unable to move his right limbs or to speak coherently because of aphasia. The lumbar cerebro-spinal fluid was turbid. Thereafter he gradually became more drowsy and stuporose, and developed bilateral papilœdema. When transferred to the Dunedin Hospital he was semicomatose. A diagnosis of left parietal abscess was made, and the brain was explored with a cannula inserted through a burr hole. Pus was encountered in the superficial part of the old missile track, and 150 cubic centimetres were aspirated. Before removal of the needle, two cubic centimetres of "Thorotrast" were injected into the abscess cavity, and we were thus enabled later to demonstrate its outlines radiologically (Figure X). This abscess was then treated successfully by repeated aspirations, until the "Thorotrast" shadow had contracted down to a narrow kernel, indicating that the abscess had "healed" by cicatrization. It was not excised, as in the preceding case, because it lay beneath the motor cortex and the lower part of the left parietal lobe, and consequently its operative exposure would have been followed by a pronounced and permanent degree of aphasia. The organism responsible in this case was the *Staphylococcus aureus*, and presumably had been introduced at the time when the patient was wounded, before the scalp wound had healed. It must subsequently have lain dormant for more than five years, and as the abscess has not been excised, it is unfortunately potentially liable to flare up again.

CASE VII.—*Example of a Recurrent Brain Abscess Following Treatment by Drainage.* A soldier received at Alamein a penetrating injury in the right frontal region. Shortly afterwards he developed an acute cerebral abscess, which was drained, apparently with success, for within a few weeks his wound had healed. On the voyage home, however, his wound broke down and discharged for a week or two, but soon healed over again. Some weeks after his return he experienced severe headaches, had several epileptic fits, and developed a discharging sinus once more (Figure XI). When he was admitted to the Dunedin Hospital approximately twelve months after being wounded, X-ray examination revealed a small skull defect in the sinus, while encephalography showed a slight displacement of the ventricular system away from the defect. At operation an osteoplastic flap was turned down, and an abscess containing ten cubic centimetres of staphylococcal pus was excised completely, together with the sinus track. The patient made an excellent recovery.

CASE VIII.—*A Second Example of a Recurrent Brain Abscess Following Treatment by Drainage.* This soldier's history was similar. He had received in the Middle East a penetrating injury in the left frontal region, which shortly afterwards had become complicated by a cerebral abscess. This was opened and drained on two occasions, and after discharging for some months appeared to have healed. Eight months after he was wounded, however, his wound broke down and started discharging once more (Figure XII). X-ray examination revealed a small abscess cavity outlined by "Thorotrast" (which had evidently been injected into the abscess while he was overseas). Air encephalography, however, did not show any indentation of the

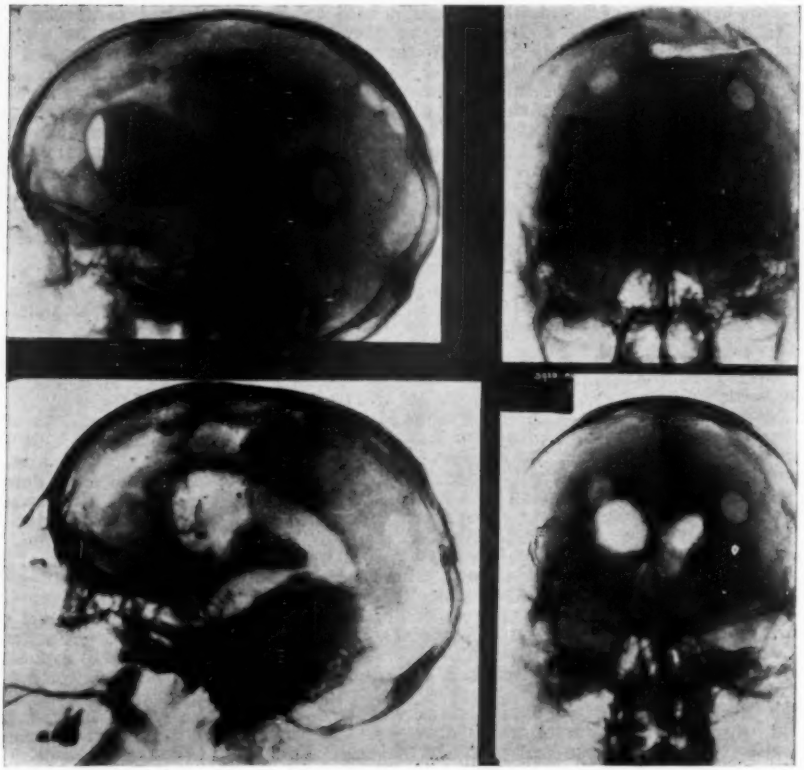


FIGURE IX. Case V. Top, radiograph shows abscess cavity outlined with "Thorotrast" (and a bubble of air) in relation to a right frontal skull defect. Bottom, the abscess has contracted following repeated aspirations to less than one-quarter its original size and presents wavy, wrinkled outlines; the ventricles have been outlined with air, and the right lateral ventricle shows relative dilatation, but no evidence of displacement or local deformity.

FIGURE X. Case VI. Left, several metallic fragments are scattered along track taken by main fragment, which entered skull near vertex and finally lodged in left frontal region. Right, the abscess cavity in the more superficial part of the missile track has been outlined with "Thorotrast".

FIGURE XI. Case VII. Top left, radiograph shows skull defect in right frontal region. Top right, photograph shows sinus orifice. Bottom left, ventriculogram reveals slight degree of shift indicating space-occupying lesion between ventricles and skull defect. Bottom right, the healed triradiate incision through which an osteoplastic flap was turned and the abscess excised.

FIGURE XII. Case VIII before operation. Left, photograph shows sinus orifice. Middle, radiograph shows abscess cavity outlined with "Thorotrast" below and behind skull defect. Right, ventriculogram shows relative dilatation of left lateral ventricle without affording any indication that a space-occupying lesion exists between the ventricle and the skull defect.

FIGURE XIII. Case VIII after operation. Left, photograph shows triradiate scalp incision. Top right, radiograph shows siting of bone flap. Bottom right, abscess with centimetre scale.

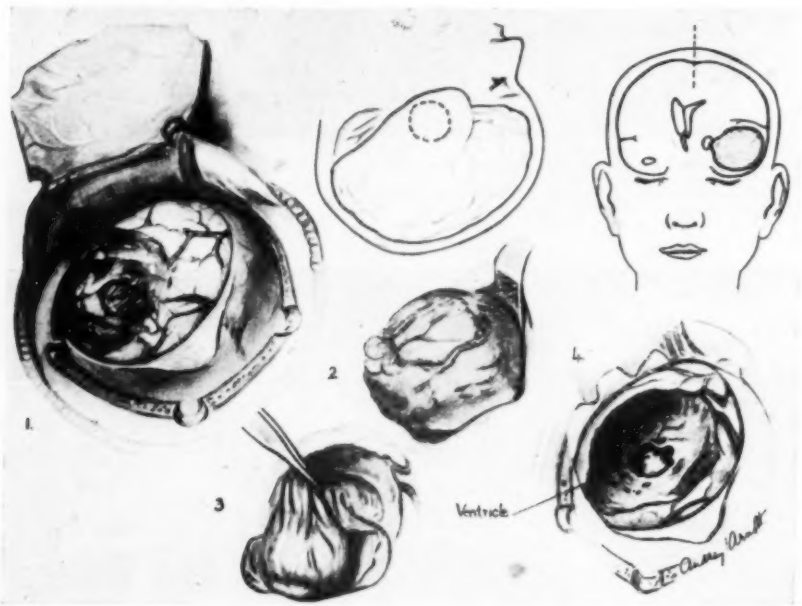


FIGURE XIV. Principal stages in the excision of a left temporal abscess, the location of which is shown in the insets. (1) After reflection of osteoplastic flap and incision of dura, the thinned and discoloured cortex over the abscess is revealed. (2) The abscess capsule has been dissected around its sides. (3) The abscess has been made to collapse by aspiration of its contents so as to facilitate the deep dissection. (4) The cavity in the brain following excision; in this case the ventricle was opened.

ventricles at this point (another instance of encephalography failing to disclose the whereabouts of a cerebral abscess). This abscess was then excised in a similar manner to that of Case VI with a satisfactory result (Figure XIII).

In the three cases in which the abscess was situated in a comparatively silent part of the brain, final treatment consisted of an excision of the abscess *in toto*; by this means the patient was completely freed from the risks of a persistent intracranial infection, which might later flare up again. In the case in which the abscess lay deep in the left parietal lobe, excision was not undertaken because the resection of a block of brain tissue necessary for adquate exposure of the abscess would have left the patient permanently incapacitated by aphasia. When a risk of this sort is not present (as in Case V) it is preferable to excise these large and chronic abscesses, because it is doubtful if they can always heal by the ordinary processes of granulation without small pockets of pus being cut off and persisting as latent foci of infection from which further trouble may arise. Such a sequence of events evidently occurred in Cases VII and VIII, for in them the abscess recurred following initial successes by drainage.

For these and other reasons I have become convinced that whenever it is practicable the most satisfactory method of treating brain abscesses, both after penetrating injuries as well as after mastoid and paranasal sinus infections, is to aim at their complete excision. In 1937 the French neurosurgeon Clovis Vincent described a method of deliberately treating acute abscesses by aspiration and osteoplastic decompression until such time as the formation of a capsule was sufficiently advanced to permit of the abscess being excised like a tumour.[5] Since then this method has been developed by certain of the younger neurosurgeons in England[6][7] and has reached a high pitch of efficiency. A detailed consideration of this method of treatment is outside the scope of this paper, but Figure XIV illustrates well the principal stages in the operative excision of an encapsulated brain abscess.

THE EXCISION OF BRAIN SCARS.

Finally let us discuss briefly the excision of brain scars. The problem, of course, arises in cases of post-traumatic epilepsy. The frequency with which epileptic attacks occur after penetrating skull wounds has been estimated from as low as 9·8%[9] to as high as 45%,[9] but fortunately in only a proportion of cases do epileptic attacks become permanently established. In the selection of patients for operation there are two principles to be considered which are not as widely appreciated as they should be. The first concerns the time of onset of attacks, and was clearly demonstrated by Ascroft in his survey of British Ministry of Pensions records.[2] Operative excision of a brain cicatrix should not be contemplated until more than two years have elapsed since the wound was inflicted, for in many cases the liability to epilepsy is only temporary, and the earlier the attacks appear after the occurrence of the wound, the more likely are they to be of only temporary duration (see Case IV). However, when the onset of attacks is delayed beyond two years, the attacks are usually persistent. The second and even more important rule is that no patient should be submitted to operation unless adequate treatment with phenobarbitone and other anticonvulsive drugs has been tried and has failed. I have seen more than one case in which an operation for excision of a brain scar had been carried out without due regard for these principles, and in which attacks continued after operation until proper medical treatment was given for the first time.

The successful excision of a brain cicatrix requires all the appurtenances of modern neurosurgery. It is important that the scar should be widely

excised. It is also important to realize that the scar when exposed may be more extensive than was anticipated.

CASE IX.—*Example of an Extensive Brain Scar Accompanying What Might Casually have been Regarded as only a Superficial Injury.* A thirty-six years old sergeant was wounded at Crete in 1941 by a shell splinter which depressed the skull in the left parietal region, but did not quite penetrate it (Figure XV). He did not immediately lose consciousness, but with the aid of friends was able to walk to a shelter. There he lapsed into drowsiness. Subsequently he had no recollection of what happened in the next three weeks, during which time he was transported, a prisoner of war, into Germany. On regaining consciousness, he found himself with a severe right-sided hemiplegia and a gross speech disturbance, which, however, slowly and almost completely disappeared over the next twelve months, leaving only a slight aphasic disturbance and some impairment of postural and discriminative sensibility in the right hand. Fifteen months after being wounded he had his first major epileptic

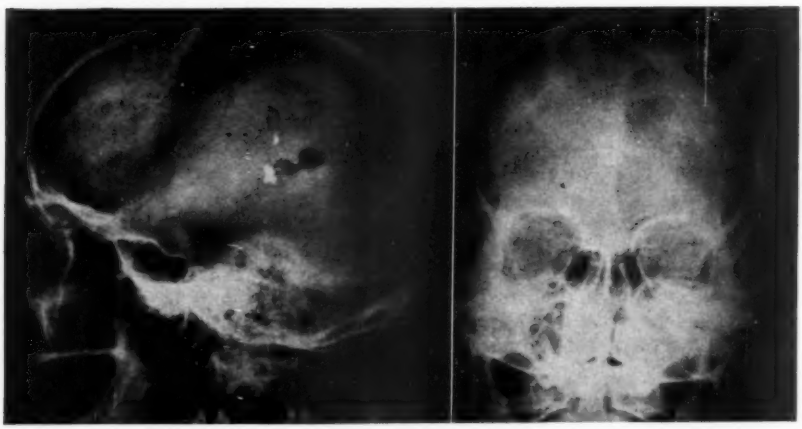


FIGURE XV. Case IX. Radiograph showing depressed fracture in left parietal region with metallic fragments superficial to it.

attack, and thereafter at intervals of six to twelve months he had further major attacks, each of which began with twitching movements of the right hand. In addition, at about fortnightly intervals he experienced minor Jacksonian attacks confined to the right upper limb. After his repatriation he was adequately treated with phenobarbitone and other sedatives, but his attacks persisted, and consequently, three years after being wounded, he was sent to the Dunedin Hospital with a recommendation that the depressed fragments of bone be elevated. At operation, however, I found clear evidence that the mere depression of bone fragments was not an exciting factor for the epileptic attacks. Instead I found that the underlying brain over an area five by four centimetres was necrotic and discoloured, and showed all the characteristics of a cerebral infarct (Figure XVI). This damaged area was therefore carefully excised, and subsequently the patient made a good recovery after a period of temporary aggravation of neurological signs. Since operation he has continued to have epileptic attacks, but they are less frequent and less severe.

This, although strictly speaking not an example of a penetrating head injury, is none the less a good illustration of the type of problem which we are going to see with increasing frequency in the future. Those meningo-cortical cicatrices which follow actual penetration by metallic fragments present similar problems. We have yet to learn what results can be obtained by modern neurosurgery in a large series of cases. My own experience is small, but judging from the experience of Penfield[10] with closely similar lesions of a more civilian character, cure may be expected in about 25% of cases and improvement in another 50%.

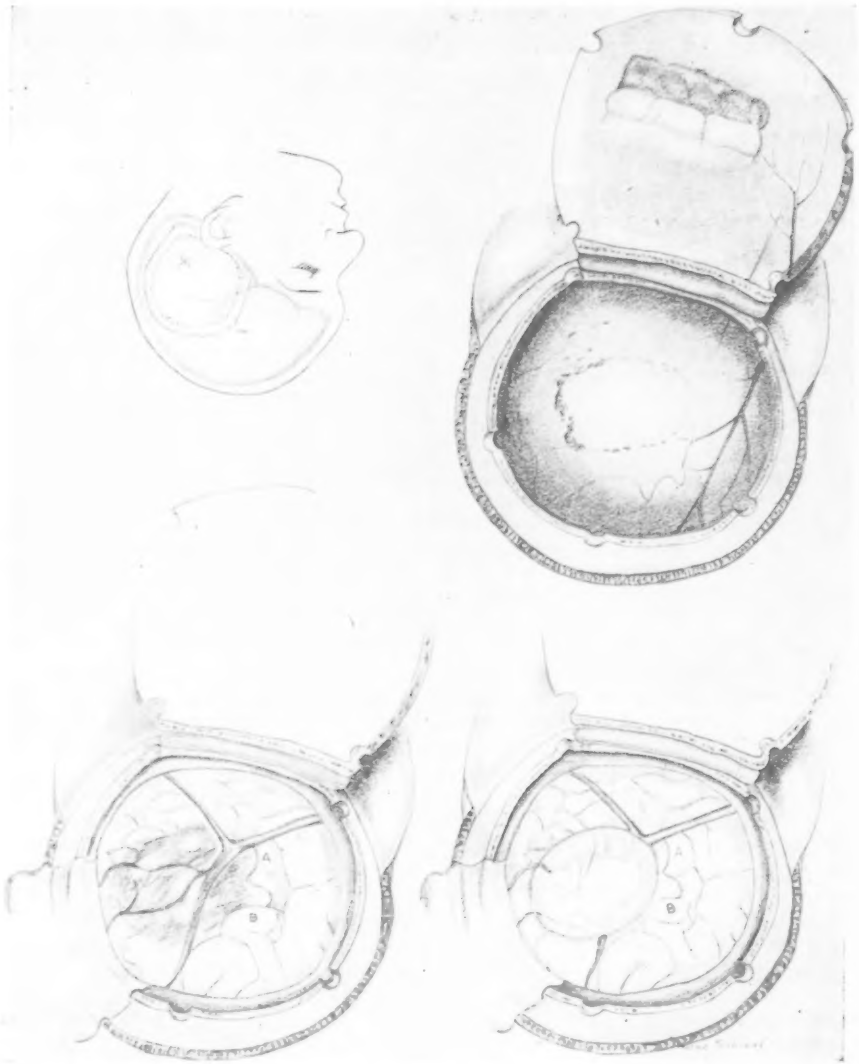


FIGURE XVI. Operative findings in Case IX. Top left, inset shows siting of scalp and bone flaps in relation to scalp puncture wound marked by cross. Top right, appearances on reflection of bone flap; the dura is intact but the skull shows a depressed fracture. Bottom left, the brain infarct immediately behind the excitable motor cortex revealed after reflection of dura. Bottom right, the brain cavity after excision of the cerebral infarct. A = twitching right side of face; B = twitching right hand.

CONCLUSION.

These are the main surgical problems that arise in the later stages of penetrating wounds of the brain. Other aspects, such as the peculiar complications and potentialities of wounds involving the paranasal sinuses, the development and treatment of carotico-cavernous aneurysms, and other vascular abnormalities, might be discussed. But enough for the present.

Discussions such as these should help us to understand the problems of head injury, which in these days unfortunately we constantly encounter.

ACKNOWLEDGEMENTS.

My thanks are due to Miss Audrey Arnott, of Oxford, England, and to Miss Valerie Tregonning and Mr. C. Weedon, of Dunedin, New Zealand, for their help with the illustrations; also to Miss E. Madigan for assistance in the compilation of this paper.

REFERENCES.

(1) H. Cairns: "Gunshot Wounds of the Head in the Acute Stage", *British Medical Journal*, Volume i, 1944, page 33.

(2) P. B. Ascroft: "Traumatic Epilepsy after Gunshot Wounds of the Head", *British Medical Journal*, Volume i, 1941, page 739.

(3) M. A. Falconer and D. S. Russell: "Experimental Traumatic Cysts in the Rabbit", *Journal of Neurosurgery*, Volume i, 1944, page 182.

(4) F. C. Grant and N. C. Norcross: "Repair of Cranial Defects by Cranioplasty", *Annals of Surgery*, Volume cx, 1939, page 488.

(5) C. Vincent, M. David and H. Askenasy: "*Sur une méthode de traitement des abcès subaigus et chroniques des hémispheres cérébraux: Large decompression, puis ablation en masse sans drainage, ou ablation en masse sans drainage*", *Journal de Chirurgie*, Volume xlix, 1937, page 1.

(6) J. B. Pennybacker: "Brain Abscess", *Journal of Neurology and Psychiatry*, Volume iv, 1941, page 274.

(7) D. W. C. Northfield: "The Treatment of Brain Abscess", *Journal of Neurology and Psychiatry*, Volume v, 1942, page 1.

(8) W. O. Gliddon: "Gunshot Wounds of the Head: A Review of the After-Effects in 500 Canadian Pensioners from the Great War, 1914-18", *Canadian Medical Association Journal*, Volume xlix, 1943, page 373.

(9) H. Cushing: "Study of a Series of Wounds Involving the Brain and its Enveloping Structures", *The British Journal of Surgery*, Volume v, 1917-1918, page 558.

(10) W. Penfield and T. C. Erickson: "Epilepsy and Cerebral Localisation", 1941, page 280.

ECTOPIA VESICÆ.[1]

By H. P. Pickerill and C. M. Pickerill,
From the Plastic Surgery Department, Wellington Hospital, New Zealand.

Ectopia vesicæ or exstrophy of the bladder is probably the worst and most distressing congenital malformation which afflicts human beings. Its frequency has been placed at about one in fifty thousand births. Hamilton Bailey made a slip when he said that it affected males only, and he was corrected by Rendle Short.[(1)] We have had one case in a girl, and Young's case, in which control of the bladder was obtained for the first time in surgical history, occurred in a girl. Nevertheless the condition preponderatingly affects males.

Ætiology.

The most important defect is undoubtedly the osseous one. The pubic bones fail to unite, and each rectus muscle, being attached to the end of a pubic bone, is widely separated from its fellow below and thus leaves a large triangular defect in the abdominal wall. The anterior wall of the bladder fails to join in the mid-line and the skin also fails to unite; the margins of the bladder unite instead to the external skin at each side. Thus a large hiatus is left in the lower part of the abdomen through which the bladder herniates. The pressure of the abdominal contents causes the posterior wall of the bladder to be pushed forwards to the utmost extent, and to assume in appearance a round angry red mass. If the subject is a male, there is always an accompanying complete epispadias. The picture is strikingly like that of cleft palate—lack of osseous growth and non-union in the mid-line, non-union of muscles and fasciæ and abnormal union of mucous membrane to skin. It is significant, too, that the defects occur at about the same time, namely, towards the sixth or eighth week of fœtal life. But whereas in at least 40% of cases of cleft palate some hereditary history can be obtained, we have never obtained or heard of any such history in connexion with *ectopia vesicæ*. What is it that causes this arrest in early development? In the case of palatal arrest the only (unintentional) animal experiments are those which occurred some time ago (1913) in certain of the animals at the *Tiergarten* in Berlin. Thirty jaguar cubs were born with cleft palates and they all subsequently died. The mothers had been fed on ordinary butcher's meat. The diet was thereafter changed to freshly killed meat fed to the animals whilst it was still warm and no more cleft palate cubs were born. If we can assume anything from this, it is that extreme freshness of food is an important factor for expectant mothers even in very early stages.

There is another somewhat suggestive fact that in transverse sections of the head in all early fœtuses the tongue appears unduly large and lies high, intervening between the early palatal processes. It is obvious that unless the tongue descends, the lateral processes of the palate cannot possibly come together. One is tempted to ask: does a similar thing happen in the lower abdominal region in the second month—does some abnormal intraabdominal pressure extrovert the bladder or fail to be relieved at the critical moment and prevent the pubic processes coming together? Or it may be that the allantoic duct or belly stalk may intervene? These structures between the first and second month appear to lie folded downwards flat upon the primitive

[1] Accepted for publication on May 25, 1945.

bladder, and if they do not rise, or if the allantoic duct does not diminish as it should, or the latter become distended, as has been suggested, fusion of the pubes may well be prevented. The strong retraction of the penis and the absence of umbilicus in these cases should be valuable pointers in determination of cause. It would be of considerable interest if obstetricians would record the exact relationship of the attachment of the umbilical cord in *ectopia vesicæ* cases at birth. These are problems of great interest and importance which await solution by the embryologist.

TREATMENT.

To those having to deal with this surgical condition, the present writers included, it has seemed obvious, nay imperative, that the first step must be to get the pubic bones to approximate in order to bring the recti together, and many attempts have been made to this end, but, so far as can be ascertained, without a single success by any surgeon (including Trendelenburg). Even in babies under three months of age the resistance of the pelvic girdle to narrowing either by immediate means or by prolonged circumferential strapping with "Elastoplast" is tremendous. It must be recognized that in addition to separation there is also lack of development of the pubic bones. The distance between the bone ends at three months of age may be two and a half to three inches, and this would appear to be an insuperable barrier.

Of recent years implantation of the ureters into the bowel has been practised so widely for other conditions that genito-urinary surgeons have almost claimed that all patients with *ectopia vesicæ* should be treated similarly. With the increasing development of the transplanting operation it offers an easy way out; but is it the best for the patient in the long run? At least since Young's epoch-making operation this method warrants serious consideration in every case. If this operation can be perfected so that urinary control can be definitely relied upon, then there will be no question as to the right method of treatment. But even if the operation fails to give control, is it worth while? We think the answer is definitely "yes". In the male it is a difficult and prolonged business, but it gives results in that it can restore a patient to social circulation with surprisingly little disability.

If transplantation of the ureters is done, it still leaves the bladder and, in the male, the epispadias to be dealt with. If the bladder is left it is exposed to much superficial irritation which eventually in a considerable number of cases (30%) causes malignant changes. The bladder must either be removed or still be closed by plastic operations; if it is excised as some surgeons recommend, what is to be done about the epispadias, remedy of which would then be practically impossible? Amputation of the penis has been suggested. We regard this as an unjustifiable mutilation. In addition there has to be taken into consideration the possibility that the transplantation on one or both sides may not be successful, so much depends apparently upon the type of operation chosen and the skill and experience of the surgeon. There is, too, always the continuing risk of an ascending pyelitis, though it is claimed that this is a diminishing one.

There is the further consideration, in our opinion highly important, of the psychological effect on the patient of the persistence of an ugly irritable disfigurement or other obvious defect of the genital region, which has at all costs to be kept secret. We think, too, it may be justly claimed that the operation of transplantation of the ureters is of such a kind that the patient himself should, if possible, have some part in the decision whether it should be undertaken. We therefore explain to parents exactly what we propose to do and its possible or probable limitations, and tell them about trans-

plantation of the ureters, and advise that when the boy is old enough to judge for himself he should consult a genito-urinary surgeon about it.

CLINICAL HISTORY OF TWO PATIENTS TREATED BY THE YOUNG OPERATION.

The first patient, a boy aged eleven years, had complete extroversion of the bladder with a wide open flat epispadias. The bladder looked like a large crenellated overripe tomato adherent to the lower part of the abdominal wall. The penis was as usual drawn upwards and backwards so that only the undersurface was visible, the dorsal surface being closely approximated to the bladder wall, as will be observed by reference to Figures I and II. The scrotum was practically undeveloped and no testes were palpable. There was very little prepuce. X-ray and manual palpation showed a three inch gap in the pubes (see Figure IV). The boy had never been to school, he could neither neither read nor write, had never worn boy's clothes, and had been kept in strict

FIGURE I. *Ectopia vesicæ.* Note: 1. Protrusion of posterior wall of bladder. 2. Retraction of penis and close approximation to bladder. 3. Diminutive prepuce.

FIGURE II. Penis retracted to show complete, flat, wide epispadias. The orifices of the ejaculatory ducts can just be seen.

seclusion. He would speak to no one, he glowered and scowled and fiercely resented any examination. It took us some weeks to gain his confidence; in this we were greatly helped by the sister in charge of the ward and by the hospital school mistress. Having thawed him out somewhat, we proceeded to the Young operation. For full and excellent details of this we would refer those interested to the original article in *Surgery, Gynecology and Obstetrics*, March, 1942, page 729. Young did the operation in one stage; we employed two. The first stage consisted in making two incisions along the outer margins of the recti and exposing these muscles from the pubes to well above where the umbilicus should be. Two rectangular flaps of fascia were raised the full width of the recti; these were left attached at their lower ends and replaced and the incisions were closed. This delayed method in using flaps in plastic surgery often increases viability and we were anxious to have the least possible chance of any sloughing. The second stage was undertaken a fortnight later. "Pentothal" anæsthesia and continuous administration of oxygen were used and the head of the table was lowered until, with very gentle pressure, the bladder sank back from a convexity into a concavity (see Figure III). An incision was carried all round the bladder at its cutaneous attachment and the previously fashioned flaps were drawn out. This incision was deepened by very careful dissection until it was judged that the posterior surface of the bladder had just been reached, when it was found that the anterior margins of the bladder wall could then be approximated readily and sutured together. In the making of this circumferential incision great care has to be taken at the point where the umbilicus should be or the peritoneal cavity may be opened and urine run in before one is aware of it. The fascia flaps were then placed in the form of a Saint Andrew's cross on top of the bladder and sutured to the opposite recti muscles. This, in our opinion, is the essence of the Young operation. The crossed flaps of fascia take the strain and prevent

the bladder from bursting forth again in a week or ten days, as it nearly always does if they are not used. It was then seen that the skin came together over the bladder without much tension; lateral incisions were used, but these soon closed. To gain control, the neck of the bladder was dissected up in the same way as the rest of it, brought together and firmly sutured over a very small catheter. A perforated rubber tube was placed transversely in the upper part of the bladder through incisions made

FIGURE III. Patient in head-low position. Note: 1. Complete retraction of bladder. 2. Further retraction of penis. 3. Absence of scrotum. Testes just palpable high in inguinal canal.

in its wall, to drain urine. The patient was placed in bed at the same angle as he was on the operating table—that is, with head low—and very gentle continuous suction, under the supervision of a special nurse, was applied to the drainage tube. The wounds were painted at the conclusion of the operation and daily with *Tinctura Benzoini Composita*; no other dressings were applied. After the wounds had healed and the sutures and drainage tube had been removed, the patient was placed in the reverse

FIGURE IV. X ray showing three inches' separation of the pubes.

position—that is, with head high—to facilitate drainage of urine through the catheter. It, however, became evident at the end of the first week that the suturing of the neck of the bladder had given way, for urine was coming freely all round the catheter; the latter was therefore withdrawn. An attempt was made later to resuture and narrow the opening, just as Young had to do in his patient; but he had the advantage of having a girl to operate on, whereas in our boy the openings of the ejaculatory ducts, which were plainly visible, could not justifiably be encroached upon and the *corpora cavernosa* present highly unsuitable tissue for plastic operations. This operation

also failed to give retention. We therefore decided to defer this to a later date and to proceed with the epispadias.

We find there is an impression that whilst hypospadias may be perhaps successfully treated, epispadias is inoperable. This is far from the truth. We have never found real difficulty in dealing with any case of epispadias. On the whole it is simpler and less worrying than hypospadias. The latter we like to begin to treat within the first two months of the patient's life by excising the fibrous tissue causing the recurvature and replacing it with a skin graft. Then eighteen months later we construct in four stages the floor and walls of the urethra from a tube graft made from the prepuce, the latter being in hypospadias always superabundant. In epispadias the prepuce is diminutive and of no value to the plastic surgeon. Points which seem to be missed often in descriptions of epispadias are that the floor of the urethra lies on the dorsal surface of the penis: it is not merely "absence of the upper wall of the urethra"; further, the glans is often turned completely round so that the cleft

FIGURE V. Front view two years after bladder closure by Young operation and correction of epispadias by epithelialized tube graft. Note development of scrotum and descent of testis. (Flashlight photograph; hence depth of focus is not good.)

FIGURE VI. Side view of patient demonstrating normal morphology.

is dorsal and not ventral. It would almost appear that the whole organ was turned round through 180°, and if so it is the sides and floor which are missing just as in hypospadias. Owing to the absence of the *symphysis pubis* the urethra is much shortened and the *corpora cavernosa* appear to be closely approximated to the base of the bladder. The membranous urethra is absent.

To remedy the epispadias and construct a urethra and prepuce a tube graft was constructed in the left loin. The lower end of it was next opened up and the inner surface epithelialized. The whole graft was then caterpillared down into position so that the epithelialized portion would lie nicely over the glans and penis and was then sutured into position. At the final stage the tube was divided and sutured to the base of the bladder and abdominal skin and the remainder was discarded.

A prepuce has to be made in epispadias to direct the urinary flow forwards and downwards, otherwise it may tend to run backwards towards the pubis and may not be caught in a receptacle. These grafts take with

great certainty, provided that they are handled gently, that the fit is very accurate and that there is no unnecessary trauma from coarse suturing.

The grafts having settled down, the patient was fitted with a colostomy bag, which he soon learned to manipulate himself and to empty three times a day. He was then sent home, but not before we had taken a moving picture of him running round and round a lawn dressed in boy's clothes for the first time in his life.

There is another variation of these conditions, one of which we have under treatment at the present time, which may be regarded as half-way between simple epispadias and *ectopia vesicæ*. There is complete epispadias, but no ectopia, and the abdominal wall is intact; there is, however, a small gap in the pubes and one's little finger can be passed with ease into the bladder.

Whilst the first boy was in hospital, another boy came in of the same age with precisely the same history and exactly the same condition. There was, however, a very important difference. The second boy was a weakling. He too resented examination, but showed it by curling up in a ball and weeping. His tissues had not sufficiently quick healing properties; he caught every wave of cross-infection invading the ward.

FIGURE VII. *Ectopia vesicæ* in a girl.

As a consequence, treatment was prolonged and tried the patience of all concerned to the limit. Eventually the bladder was closed, except for a small leak on the left side, and the epispadias was corrected. But again no sphincter control was obtained. The morphological result was not so satisfactory as in the first case. He was sent home with a colostomy bag, and his parents were instructed as to building up his general health and physique and to bring him back for further treatment when this had been attained.

When these patients were shown at a meeting the questions were raised: "Are these operations justifiable?" "Do they enable the patient to live any longer or to live a useful life?" Perfectly sound criticism and one which might be applied to every operation. At the moment we were unable to answer these definitely, except to say that at least the patients had been saved from the chances of malignant bladders; but we remembered a certain patient whom we had operated on successfully by using an epithelialized tube graft (but without the patient's obtaining control) in a girl at the request

of Sir Louis Barnett about twenty years ago. Shortly after, meeting a doctor from the far south of New Zealand, we asked him did he by chance know or had he ever heard of a certain Mary X who once had an *ectopia vesicæ*. "Yes", he said, "she is a patient of mine, only her name is now Mary Z, and she is the mother of a fine little girl." "Well", we said, "so Mary is married!" "Yes, and very happily married", said the doctor. "She does all her house work, goes into town and does all her shopping and really shows remarkably little disability. She sometimes wears a bag and sometimes a towel." We subsequently sent the doctor the photograph taken in 1925, and shown in Figure IX, for comparison with the present condition, and he reports: "The graft covering the ectopia is in excellent condition, just as shown in the photograph, and her general health is good."

FIGURE VIII. Tube graft for closure of ectopia. Upper end epithelialized underneath and then caterpillared down into position.

FIGURE IX. Closure of *ectopia vesicæ*. The first graft contracted (was not cut large enough) and had to be supplemented by a second one. Photograph taken in 1925. Present condition identical except for removal of the surplus tube graft.

It is now two years since the operations described above were done and the first of the boys has reported back for examination.

He wears his colostomy bag, says it is no trouble and does not worry him at all. All comfort is of course purely comparative and subjective. Vesical and genital development has proceeded most satisfactorily; the bladder measures nearly three inches in transverse and vertical directions. The scrotum has developed well, one testis is down in position and the other nearly so. There is now an almost normal appearance, the boy is not ashamed to be seen naked by his fellows, he plays games, goes to school and is making very good progress. His disposition is completely changed; he is a happy, smiling, attractive lad. (In fact, he reminds us very much of the boy in "My Friend Flicka".) His mother says she has only one complaint—that she cannot keep him off a horse's back.

These two follow-up histories provide, we think, very satisfactory answers to the questions raised. It will be of interest to note in a few years when this boy has grown into a man and marries, as we have no doubt he will, whether he has normal powers of procreation. We see no reason at all why he should not have, and, if so, it will be another strong point in favour of this type of operation. He has now obviously reached puberty, and on

the slightest stimulation, even during examination under an anæsthetic, gets strong erections, and this uncontrollable violent physiological distortion of the tissues renders at present any further operative procedure unwise because of the sudden disruption of sutures which inevitably occurs. We propose at some suitable time to narrow the neck of the bladder considerably and to surround it with ribbon gut or *fascia lata*.

REFERENCE.

(1) *Medical Annual*, 1943, page 43.

THE PLACE OF SURGERY IN THE TREATMENT OF PULMONARY TUBERCULOSIS.[1]

By C. J. Officer Brown,
Melbourne.

The aim of treatment for pulmonary tuberculosis is to control the disease so that the patient may return to active life with a reasonable prospect of continued good health and free of the risk of infecting those with whom he comes in contact. However much improvement may be made in other ways, a person is unlikely to remain well unless tubercle bacilli have been eliminated from the sputum. Since in the vast majority of cases positive sputum comes from open cavities, closure of cavities is the *sine qua non* of sputum conversion. Very few cavities over one inch in diameter will close with rest and sanatorium routine alone, and for this reason collapse therapy is used in the treatment of 50% to 80% of the patients in many sanatoria. It is beyond dispute that collapse methods have greatly improved the results of treatment and are indispensable if the average patient is to have a reasonable chance of relief.

Collapse has no place in the treatment of the "hopeless chronic". When sputum conversion is impossible steps should be taken to minimize the risk to the community and to enable the patient to live as usefully as his condition permits. The patient with a minimal lesion without cavitation may do well with rest alone, but even for these cases Wingfield and others advise a small pneumothorax. Pope and Chadwick present statistical evidence of the importance of collapse in adolescents even for minimal disease. Between these two extremes we find the vast majority of patients with more or less advanced disease, with cavities and positive sputum. With rest their general physical condition improves, they become afebrile and put on weight, but their cavities remain open and they continue to expectorate tubercle bacilli. On discharge from sanatoria the relapse rate is high. In an industrial area in England during the period from 1929 to 1938 it was estimated that the chances of survival for patients with positive sputum were one in two up to one year, one in four up to five years, and one in eight up to ten years. Between 1926 and 1935, 4,550 patients were discharged from Minnesota sanatoria. Only 44% of patients with moderately advanced disease who had positive sputum were alive at the end of five years, but 81% of those with far advanced disease, discharged with "negative" sputum, survived this period.

Collapse treatment offers to the average patient a greatly increased chance of cavity closure with sputum conversion, and in consequence a much greater chance of survival and much less risk of infecting his fellows.

Excavation occurs as a result of caseation and softening in a tuberculous focus with discharge of the softened material. Because the parenchyma of the lung is elastic and under tension, the cavity tends to be spherical. Sometimes it is astonishing how rapidly a cavity may increase in size, and it is even more astonishing to note how rapidly it may entirely disappear, perhaps only to reappear with equally disturbing rapidity. Although in many cases cavities do grow as a result of progressive peripheral caseation, this process

[1] Read at the annual meeting of the Royal Australasian College of Surgeons, Melbourne, May 14, 1945. Accepted for publication on July 2, 1945.

cannot explain their rapid variations in size, and it is now well recognized that a mechanical factor related to the bronchial communications of the cavity is of great importance. A cavity may present one of three conditions. In the first place there may be free communication with the bronchial tree, in which case the pressure within the cavity is that of the bronchus and approximates atmospheric pressure and is unaltered by the aspiration of air from the cavity. Secondly, the bronchus may be completely, or almost completely, blocked off, so that little or no air gets into the cavity and the intracavitary pressure is negative or less than atmospheric pressure. If the bronchus becomes completely blocked, the contained air is absorbed and the cavity will disappear. Tubercle bacilli are aerobic and may die when the air is absorbed and secondary infection is not present, and so this method of cavity closure is effective and permanent unless the draining bronchus reopens. In the third place the draining bronchus may allow air to enter on inspiration when its diameter is increased, but partially block its exit with expiration, and thus act as a check valve. Under these conditions the intracavitary pressure becomes positive and the cavity will enlarge. This is the mechanism of production of the large tension or insufflation cavities which often present a very difficult problem of treatment. Cavities with negative or atmospheric intracavitary pressure usually respond well to collapse measures, but positive intracavitary pressures may seriously interfere with collapse by pneumothorax or thoracoplasty. A tension cavity may enlarge with pneumothorax and disappear when the lung is allowed to reexpand and later it may reappear. It is more likely to respond to thoracoplasty, but may reappear after an apparent early success, or an early failure may be followed later by permanent cavity closure. Tension cavities are responsible for many of the failures of thoracoplasty, and for these cases drainage or resection may be needed.

Draining bronchi are usually small and may become blocked by œdema or tuberculous involvement or even by thick, viscid sputum and variations in the degree of obstruction readily explain the variations in the size and behaviour of a cavity. The problem of treatment is complicated by the fact that a cavity may change its character from time to time in a quite unpredictable way, either spontaneously or as a result of treatment. Complete occlusion of the draining bronchus is followed by closure of the cavity. It may become a solid area in the X-ray films from inspissation of its contents or it may disappear, leaving only a scar. This seems to be the way in which spontaneous closure of large cavities may occur.

Cavities are as a rule readily recognized in good quality X-ray films, but when the diseased area is unusually dense, tomography is extremely valuable to disclose cavities that are not shown in plain films. After thoracoplasty, if the sputum remains positive, although a cavity is not visible, tomograms should be made.

Collapse measures may be reversible like pneumothorax and phrenic crush, or irreversible like thoracoplasty or phrenic avulsion. When possible, reversible methods should be chosen. With few exceptions pneumothorax should be tried first, and may be used for any type of disease, with the possible exception of acute tuberculous pneumonia. It may be used on one or both sides, provided that there is sufficient good uncollapsed lung to enable the patient to maintain an adequate respiratory reserve.

PNEUMOTHORAX.

Pneumothorax is simple and safe if it is properly controlled by screening and abandoned at once if it is ineffective and cannot be made effective by pneumolysis or the addition of diaphragmatic paralysis. In about 20% of

cases in which pneumothorax is indicated, a satisfactory pleural space cannot be found, and in at least another 40% to 50%, although a space is found, adhesions prevent the collapse necessary to control the disease. Sometimes the fusion around the diseased area is obviously inseparable, but in most cases thoracoscopic examination is necessary to decide whether the adhesions can be divided. Closed intrapleural pneumolysis will more than double the number of effective pneumothoraces and is probably the most valuable operation at present in use for the control of pulmonary tuberculosis.

PNEUMOLYSIS.

Closed intrapleural pneumolysis, or internal pneumolysis, as it is more usually called, was introduced by Jacobeus in 1913. He inserted a light-carrying telescope through a cannula into the pleural cavity and divided the adhesions with an electrocautery introduced through another cannula. Cutler, Chandler, Sellors and others have developed combined instruments for use through a single cannula, and Matson and others prefer electrosurgical methods to the cautery. The majority of operators still prefer the two cannula method and the electrocautery. The original Jacobeus telescope was constructed with right-angle vision, and this type of telescope is still widely used. My own preference is for the Coryllos instrument with a foroblique optical system, which simplifies orientation within the pleural cavity, and the electrocautery. Adhesions develop as a result of pleural irritation by the disease and are in the vicinity of the involved area and in practice are found most often in the upper part of the chest and round the apex, and tend to be posterior. Both cannulæ are usually inserted in the axilla, through the fourth, fifth or sixth spaces. The cautery should be used at a black heat just sufficient to cut through two thicknesses of gauze. It cuts slowly without smoke and usually without bleeding. If the cautery is too hot smoke obscures the view and bleeding may be troublesome, because small vessels are divided before they have been sealed. Adhesions may present as fine strings or cords or broad, thin bands or webs, and all of these are easily and safely divided, as they do not contain lung tissue and are usually avascular. Between these safe adhesions and actual areas of synthesis of the visceral and parietal pleura, which of course cannot be safely freed, are all gradations of fusion, and it is rarely possible to assess the complexity or divisibility of adhesions unless they are visualized with the thoracoscope. In nearly all cases this method of examination should be used. With reasonable asepsis and care thoracoscopy is practically free of risk. Careless introduction of the cannula might cause injury to the lung, and rarely injury to an intercostal vessel might result in severe hæmorrhage. Adhesions are carefully inspected and viewed from all angles. Sometimes lung tissue or even the prolongation of a cavity may extend right out to the chest wall, and when it seems likely that this condition is present no attempt at division should be made. On the surface of an adhesion speckled lung markings indicate its limits, and adhesions must be avoided when the markings extend to near the chest wall. Sometimes the parietal pleura may be divided at the base of an adhesion, and with a cold cautery its deeper parts may be pushed off the chest wall. Much of the fused tissue will separate easily in this way, and dense bands that may be encountered are easily cut with the hot cautery. Finally, the pleura on the opposite surface of the adhesion is reached and is pushed off the chest wall until it is sufficiently free for division. This is a tedious method and usually causes some bleeding, but if care is taken to avoid important structures it is often a method of great value. Safe adhesions of the string, cord or band type are easily divided close to the chest wall, and if the cautery is used at a slow heat the separation is usually quite dry.

Damage to the lung with the cautery may result in an immediate fistula with a spontaneous pneumothorax and later an empyema, and this is of course especially likely to happen if a cavity is opened. An area of lung may be coagulated by the cautery and when it sloughs out two or three weeks later a fistula will develop. Sometimes with large cavities the blood supply to a section of the cavity wall may come through the adhesion and this section will be devitalized by its division and will slough out about three weeks later, with the consequent development of a pyopneumothorax.

In reported series of cases the incidence of empyema varies from 1% or 2% up to 10%, depending on the skill and boldness of the operator. Where

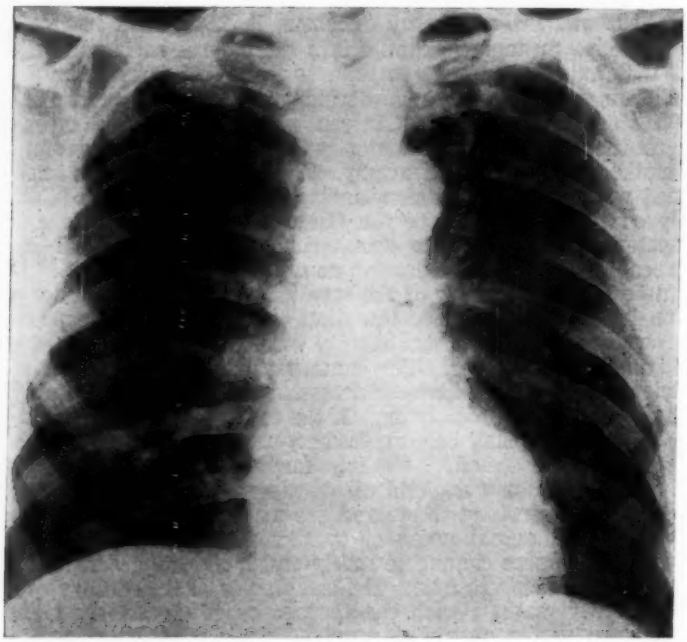


FIGURE I. Case I. Man, aged fifty-two years. Cavity in upper lobe of left lung behind first rib and in first intercostal space.

collapse is urgently needed and no other method is applicable, division of doubtful adhesions is justified, but it entails a higher empyema rate. In my first 148 cases there were 11 empyemata and three patients died as a result of the pneumolysis. Some of these operations were done by Major Paul Gebauer, of the American Medical Corps. Clear effusion follows the operation in over half the cases, but usually disappears spontaneously or after a short period of aspiration.

The second major risk of pneumolysis is hæmorrhage. Hæmorrhage may result from damage to an intercostal vessel by the trocar, and this would usually be recognized during the course of the operation. It might be necessary to cut down and ligate the bleeding vessel. More serious hæmorrhage results from the opening of vessels too large to be controlled by coagulation during the division of an adhesion. Rarely a major vessel like the subclavian vein has been opened and terrific hæmorrhage has resulted. In one such case recently reported the patient was saved by wide thoracotomy

performed without waiting for anæsthesia or instruments. Fortunately a scalpel was sterile and the patient was so collapsed that he tolerated without demur this prehistoric surgery. To avoid this risk the operator requires an exact knowledge of intrapleural anatomy as visualized with the thoracoscope and must studiously avoid the larger vessels, which may be obscured by adhesions. Hæmorrhage from an intercostal vessel might occur in the shelling out of an adhesion from the chest wall, and thoracotomy would probably be required. The bleeding would be less urgent and a deliberate operation could be performed. Lesser hæmorrhages may easily pass unrecognized until signs of internal bleeding appear or perhaps an unusual effusion

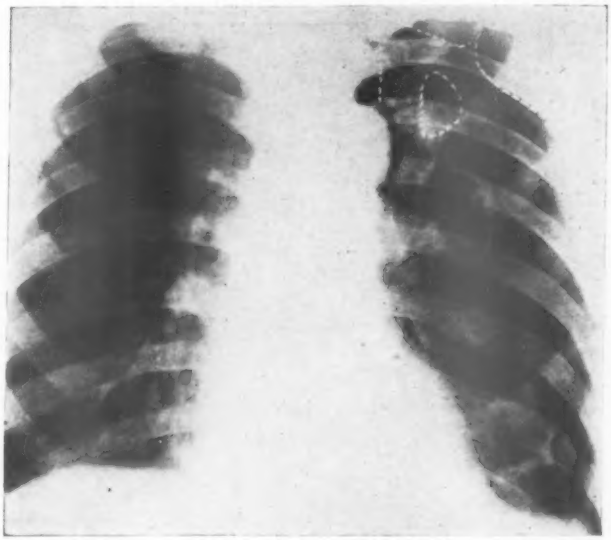


FIGURE II. Case I. After induction of pneumothorax, adhesions present laterally and at apex.

is found to be a hæmothorax. Once I had to do a minor thoracotomy four hours after pneumolysis to control bleeding from the chest wall end of an adhesion, and in two cases hæmothoraces had developed, but responded to aspiration. One of these patients developed a pneumonic spread and died a few weeks after operation. The other suffered no lasting ill effects. Lesser hæmorrhages can be controlled by the cautery tip directly applied to the bleeding point or held close to it to radiate heat, which coagulates the blood. Diathermy is more effective and may be used if it is available.

Some amount of subcutaneous emphysema usually results from leakage of air through the cannula holes, but loss of the pneumothorax is extremely rare. Every patient should have his chest screened or a film made in the first twenty-four hours after operation, and air should be added if it is required.

Pneumolysis should not be done in the presence of a recent effusion which is causing a febrile reaction, nor in the presence of a purulent exudate. Some fluid is often present and it should be removed with a sucker when the operation is done. Active tuberculous pleurisy contraindicates operation, and if pleural tubercles are present on the surface of an adhesion it should not be divided.

Pneumothorax is induced to make the lung collapse, and especially to close cavities. If it is prevented from doing this by adhesions, the adhesions must be divided, and if this cannot be done the pneumothorax should be abandoned. If pneumothorax is indicated, it should be induced early, because delay is likely to allow time for the development of adhesions. If adhesions are present, pneumolysis should be performed as soon as their presence is recognized. Adhesions rarely stretch as a result of tension; they organize and contract and become much tougher to divide. If they do rupture, it is likely that the lung will tear rather than the tough adhesion, with the risk of empyema. Adhesions are much more likely to be divisible if the disease is recent.

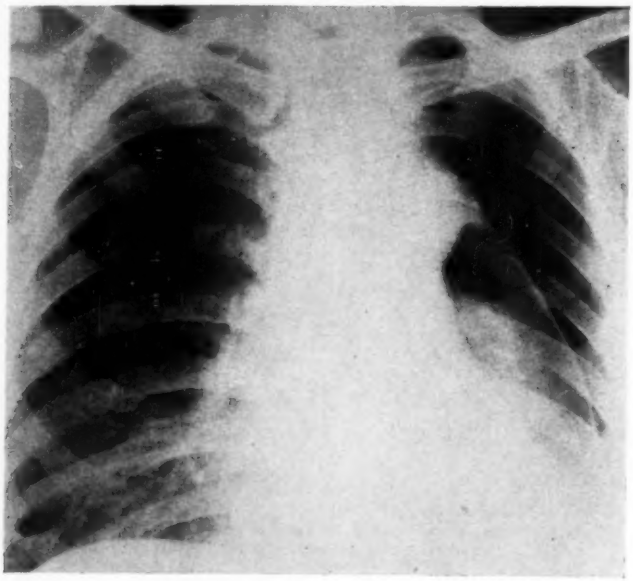


FIGURE III. Case I. Good collapse with closure of cavity following division of adhesions.

PARALYSIS OF THE DIAPHRAGM.

Paralysis of the diaphragm reduces movements of the lung and does away with the vertical drag of inspiration, and causes a reduction of 25% to 30% in lung volume. O'Brien advises phrenic crush as the method of choice for minimal lesions, and Alexander states that the response is as good with apical as with basal lesions. Although most authorities prefer pneumothorax for minimal disease, phrenic crush is worth trying when pneumothorax is impossible. It is useful as a supplement to pneumothorax when indivisible apical adhesions are exerting a vertical pull and preventing the relaxation of a cavity. Diaphragmatic paralysis relaxes the pulmonary ligament and allows the lung root to rise. Diminution of the inspiratory tug on the draining bronchus may allow it to become completely obstructed, and if this happens the cavity will close. Even in the absence of adhesions basal cavities which have failed to close with pneumothorax may disappear when a phrenic crush is added.

Where pneumothorax is impossible and thoracoplasty is indicated it may be felt that the disease is not yet sufficiently stable for the major operation

and diaphragmatic paralysis may be used as a supplement to bed rest during the waiting period, and often appears to assist the hardening process. If this is done, the phrenic nerve should be crushed and thoracoplasty delayed until the diaphragm is moving again because a paralysed diaphragm increases the risk of post-operative atelectasis as it lessens the expulsive power of coughing. Phrenic avulsion should never be done as a primary procedure. The nerve should be crushed and any accessory phrenic nerves that are found divided. This will paralyse the diaphragm in most cases for six to eight months and at the end of that time the nerve may be recrushed or avulsed if it is decided that permanent paralysis is desirable. Permanent paralysis may be

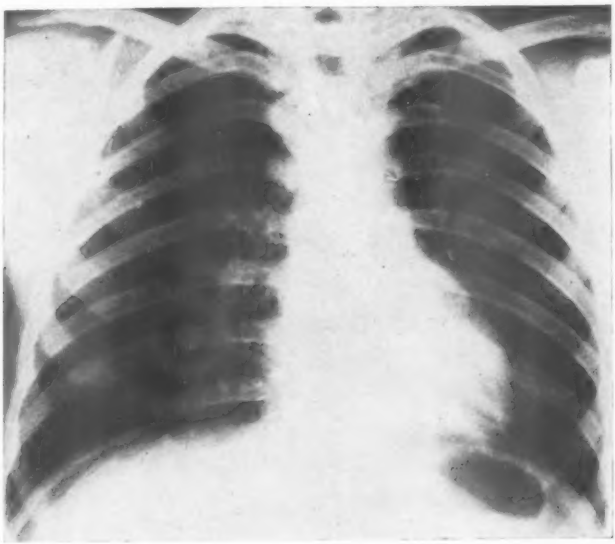


FIGURE IV. Case II. Boy, aged nineteen years. Cavity upper lobe of left lung behind first rib and clavicle. Intrapleural pneumothorax impossible.

desirable with basal lesions or to help obliterate the pleural cavity with an empyema, but with upper zone lesions if a thoracoplasty is needed later on, a permanent paralysis causes unnecessary reduction in vital capacity by reducing the function of the healthy lower lobe.

The amount of elevation of the paralysed diaphragm varies greatly. It may be supplemented by pneumoperitoneum and in some cases the diaphragm can be pushed up to the level of the anterior end of the third rib. Pneumoperitoneum is not often of value, but it has a definite usefulness and should be tried when diaphragmatic paralysis alone fails to cause improvement. The result does not always depend on the amount of elevation of the diaphragm, and because phrenic crush is almost without risk it should be tried if there is any prospect of its success. Once I produced a Horner's syndrome and once when I crushed a phrenic nerve for the fourth time I damaged the fifth root and caused a partial upper arm paralysis. These are the only complications I have seen.

THORACOPLASTY.

Thoracoplasty is the best method of achieving collapse when pneumothorax has failed or is inapplicable, and can be used in the treatment of

about 5% to 10% of patients admitted to most sanatoria. In properly selected cases it produces a satisfactory selective collapse of the cavernous lung. It is irreversible, necessitates multiple operations and produces some deformity. No patient should be submitted to thoracoplasty until pneumothorax and any other lesser procedure that might offer a reasonable chance of success have been tried. The patient must be in fairly good condition, with adequate cardiac and respiratory reserve, and the disease should be limited to one lung, or at least disease in the other lung must be non-progressive or controlled before thoracoplasty is done. The ideal patient is one who may be classed as a stationary chronic, who is non-toxic and afebrile, with strictly unilateral disease which is predominantly fibrotic. The patient has cough and sputum, which contains tubercle bacilli, but is often small in

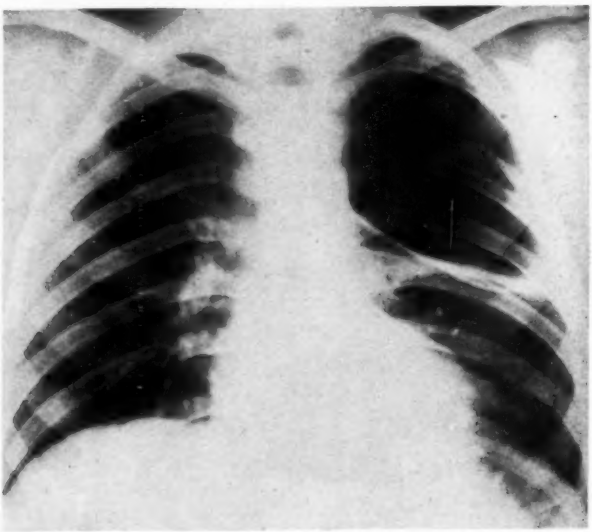


FIGURE V. Case II. Following extrapleural pneumothorax, cavity closed. Regeneration is seen in operated on part of fourth rib posteriorly.

amount. Disease on the other side that is quiescent or adequately controlled does not seriously increase the risk. The "relapsing chronic" is a patient who generally fills the requirements of the "stationary chronic" but has recurring periods of fever with increase in cough and sputum and toxæmia and a rise in the sedimentation rate. In these cases thoracoplasty should be done between relapses and will achieve a high measure of success. The "slipping chronic" is one who is steadily though slowly losing ground. Usually he is far from an ideal selection for thoracoplasty, but it offers him his only chance, and if it is delayed too long he will pass on into the group of hopeless chronics, whose condition precludes surgical aid.

Modern thoracoplasty is a fairly standardized procedure. It is performed in stages and sufficient ribs are removed to collapse the cavernous area. Usually the first three ribs are resected at the first stage. The whole of the first rib and its cartilage are always removed, the second rib is removed completely or almost completely, and slightly less of the third rib is taken. If the lung is very soft and mobile, it is safer to take only a short segment of the third rib at the first stage because of the risk of paradoxical respiration.

At the next stage, two, three or four ribs may be taken in accordance with the needs of the patient and the mobility of the uncovered lung. Hard lung may be uncovered freely, but if it is soft and mobile, it is safer to increase the stages and to remove less ribs at each stage. Sometimes an anterior stage is needed if the cavity is in front, and it is necessary to remove the second and third and possibly the fourth ribs right up to the sternum.

The incision is a large one, starting about one inch above the spine of the scapula and extending down between the vertebral border of the scapula and the spine to about the eighth rib, where it swings forward along this

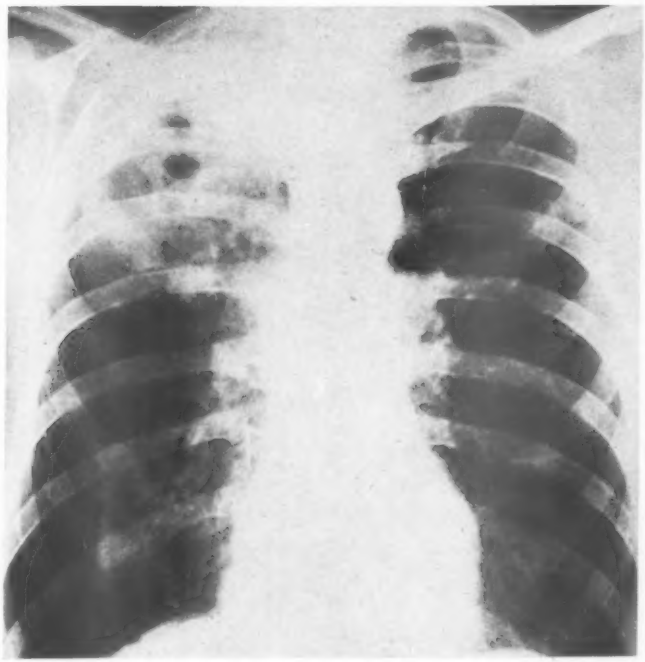


FIGURE VI. Case III. Man, aged thirty-six years. Bilateral pulmonary tuberculosis. Large cavity system with exudative disease in upper lobe of right lung. Slight infiltration in upper lobe of left lung with small cavity behind third rib. Artificial pneumothorax right side contra-selective, therefore abandoned.

rib to about the posterior axillary line. The scapula is elevated and the attachments of *serratus magnus* to the first three or four ribs are divided, and the scapula can then be lifted freely out of the way. Bleeding from the divided muscles is free and hæmostasis must be carefully attended to. For the later stages the same incision is reopened with little bleeding and rib resection is under way in a few minutes.

In 1934 Semb introduced the principle of extrafascial apicolysis as a supplement to thoracoplasty. After resection of the first three ribs the first stage is completed by dividing the attachments of Sebileau's bands to Sibson's fascia and then mobilizing the apex of the lung by separating the fascia from the chest wall and mediastinum down to about the level of the aortic arch. This procedure allows vertical relaxation as well as the lateral collapse produced by rib resection and definitely increases the rate of cavity

closure in selected cases. Price-Thomas and Overholt use apicolysis as a routine but it has not been universally accepted. It may allow an apical cavity to drop down to the broader hilar region, where collapse is more difficult. If this seems likely, the stripping should be limited to the anterior mediastinum and the paravertebral gutter, and should be sufficient to allow the apex to drop only a few inches. Janes advises that apicolysis should be reserved for patients with small thin-walled apical cavities lying medially and surrounded by healthy lung. With apicolysis less extensive rib resection may be sufficient.

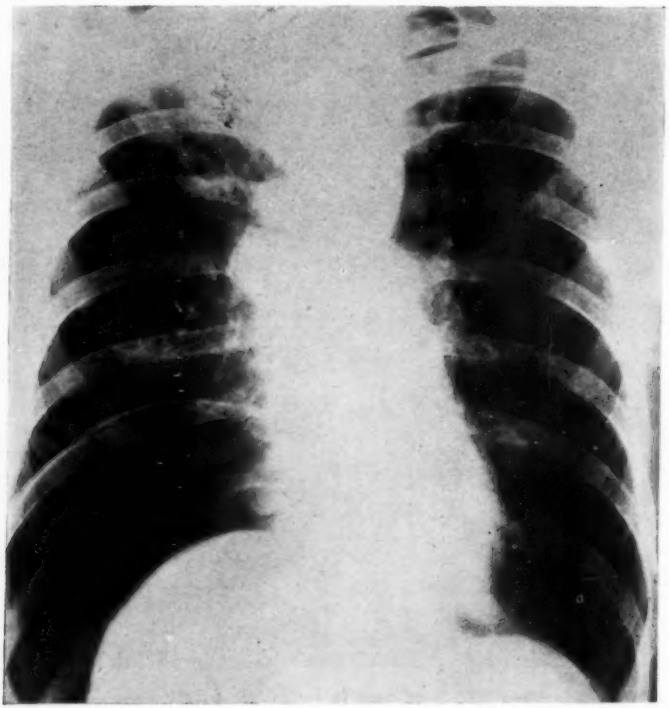


FIGURE VII. Case III. Marked improvement followed right phrenic paralysis with pneumoperitoneum. Tomograph showed residual small cavity behind clavicle. Cavity in left lung healed.

Local or general anæsthesia may be used. If general anæsthesia is chosen, the method of administration and the skill of the anæsthetist matter much more than the anæsthetic agent, and I have been fortunate in my anæsthetists. At the Austin and Alfred Hospitals Dr. Orton uses cyclopropane and oxygen for these patients, and at the Heidelberg Military Hospital Major Webb has used nitrous oxide, ether, oxygen sequence to my complete satisfaction. I consider that all anæsthetists should be skilled bronchoscopists. In this technique Dr. Orton excels.

Complications of Thoracoplasty.

Thoracoplasty is a severe operation performed on patients who have usually been more or less confined to bed for a long period and most of whom have some amount of toxæmia, and post-operative shock is to be expected.

At the first stage there is often considerable blood loss. It is my practice to establish a blood drip at the commencement of the first stage and to run in one pint of blood during the operation. At the later stages this is usually not required, but I like to feel that blood is available for the occasional patient who needs it.

Paradoxical respiration may follow the removal of too much rib and will rapidly exhaust the patient. Firm support to the decostalized area and the free use of oxygen will usually control this serious embarrassment. Damage to the pleura may be followed by hæmothorax, effusion or pneumo-

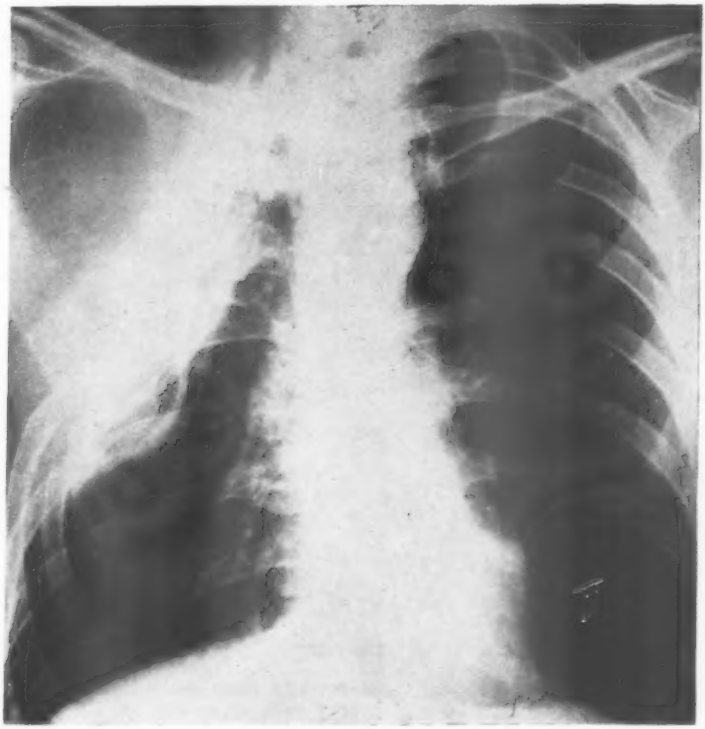


FIGURE VIII. Case III. After second stage thoracoplasty cavity right lung no longer visible.

thorax, which may cause some distress, but this is relieved promptly by aspiration. Bleeding into the space deep to the scapula, or infection of this space or of the wound occasionally occurs and requires appropriate treatment.

All these complications are unusual and readily controlled, but there are two which are more serious and more difficult to manage. These are post-operative atelectasis and spread of tuberculous disease, which may be a reactivation of preexisting disease or the formation of new foci by aspiration of infected sputum. Atelectasis results from inhibition of coughing with retention of sputum. Decostalization makes coughing painful and diminishes its effectiveness, and over-sedation which damps down the cough reflex may be a factor. Sufficient sedative should be given to control pain and then the nurse should stand over the patient and support the weak area and make him cough. Some patients are difficult, but if the need is explained

to them before operation, and if after operation they are never allowed to reach the stage of sputum retention, it is surprising how cooperative the average patient will be. Once atelectasis has developed it must be vigorously handled. The patient, suitably treated with sedatives, is placed on his good side and soundly thumped and rolled about. Usually this starts a fit of coughing with the expulsion of a plug of mucus and immediate relief. If it fails, bronchoscopic aspiration should be used, or if this is not available,

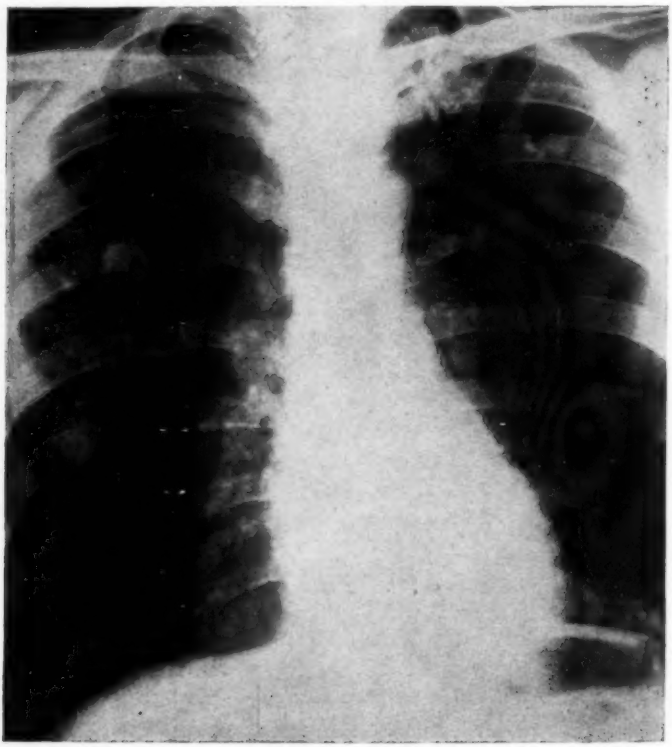


FIGURE IX. Case IV. Man, aged forty-two years. Fibro-calcareous disease both upper lobes. Cavitation behind left first rib. Exudative disease lower lobe of left lung. After twelve months' rest this had cleared, but small cavity appeared at right apex.

catheter suction of the trachea may be tried. It sounds brutal to attack a seriously ill patient with a bronchoscope a day or two after thoracoplasty or lobectomy, but it is life-saving and the relief of distress more than outweighs its disadvantages. Post-operative bronchoscopy should be used in all types of surgery if atelectasis develops or is threatened. Unrelieved atelectasis may clear spontaneously or may be followed by a non-tuberculous infection that may subside or suppurate, or it may result in spread of the tuberculous infection.

Spread of tuberculosis is always serious, and at the best results in delay in completion or abandonment of the thoracoplasty.

Modern thoracoplasty results in cavity closure and sputum conversion in about 75% of well-selected patients, with an operative mortality of less than 5%. Failure to close a cavity may be the result of an inadequate

operation, and in these cases success may follow a revision operation. If the original operation was adequate, drainage or resection may have to be considered.

APICOLYSIS WITH PARAFFIN PLOMBE.

Apicolysis with paraffin plombe is an operation that is now rarely used, but still has a small field of usefulness in closing small, deep cavities in elderly people whose cardiac or respiratory reserve would not justify any more extensive procedure, and when pneumothorax has failed to achieve relaxation.

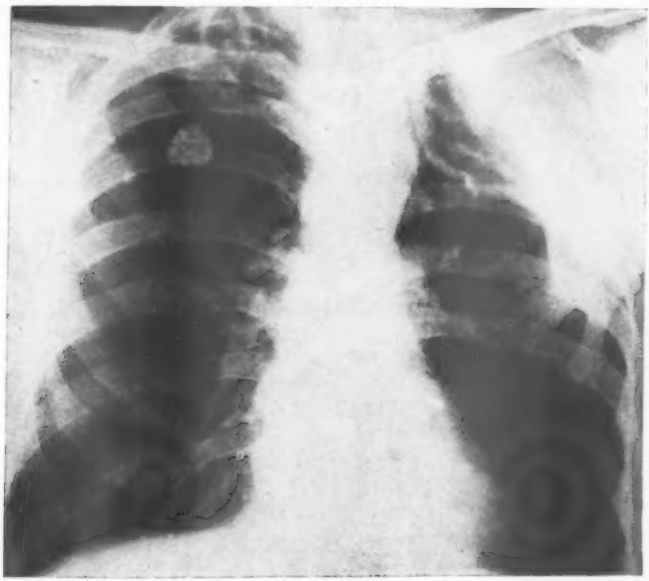


FIGURE X. Case IV. Cavity closed following left second stage thoracoplasty. Cavity right apex visible above clavicle. Right thoracoplasty decided on.

EXTRAPLEURAL PNEUMOTHORAX

Extrapleural pneumothorax was first used by Tuffier in 1891, but did not come into general use until the middle 1930's. It was adopted with enthusiasm, but it was soon apparent that except in a very small group of cases the risk of infection of the space was too high and it is now very limited in its application.

The operation is performed by resection of about four inches of a rib—usually the fourth in the paravertebral region—and separation of the parietal pleura from the endothoracic fascia. Separation is carried up over the apex and down to about the sixth or eighth ribs all round. The wound is sutured and the space maintained by refills of air under pressure. It produces at once a satisfactory selective collapse and is much less severe than thoracoplasty, and can be used on both sides or in conjunction with a contralateral pneumothorax or thoracoplasty. It should be reserved for patients with well-stabilized disease of limited extent without pleural thickening. Cavities must be less than four centimetres in diameter and not superficial. Respiratory and circulatory reserve should be adequate. Even with these

cases the operation should be abandoned at once if the pleura does not strip off the fascia easily, because it is found, where the stripping is difficult, that the incidence of infection in the extrapleural pocket, with or without a fistula, is very high.

BILATERAL DISEASE.

Bilateral disease does not contraindicate collapse therapy unless the treatment would reduce the amount of available lung tissue below that required to maintain respiration. Pneumothorax is of course the method most usually useful in bilateral tuberculosis and may be used on one or

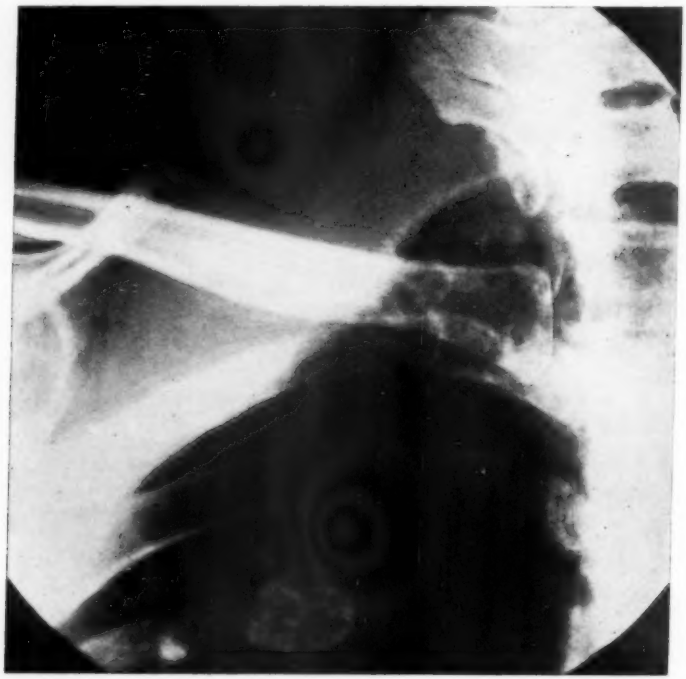


FIGURE XI. Case IV. Following first stage of thoracoplasty cavity increased in size.

both sides. Bilateral pneumothorax must be selective, with maximal collapse of the diseased areas and minimal collapse of normal lung. To achieve this pneumolysis is frequently needed, on one or both sides. Pneumothorax on one side may be combined with phrenic crush or extrapleural pneumothorax or thoracoplasty on the other side. Thoracoplasty is occasionally used on both sides. Monaldi drainage may be used on both sides or may be used on one side in conjunction with any of the collapse methods on the other side.

TRACHEO-BRONCHIAL TUBERCULOSIS.

With every parenchymatous lesion there is some associated bronchial ulceration, and when this is confined to the small draining bronchi of a cavity it plays an important part in the behaviour of the cavity and may even have a benign influence on the course of the disease. The influence of ulceration with narrowing or stenosis of a main bronchus to a lobe or a

whole lung is always malign. Although it is possible for a lobe shut off by bronchial stenosis to contract and become spontaneously healed, it is much more likely that atelectasis and bronchiectasis with putrid infection will be superimposed on the tuberculous lesion. When a whole lung is shut off the occurrence of bronchiectasis and putrid infection is almost inevitable.

Pneumothorax should never be advised in patients with severe bronchial ulceration or stenosis, because with the progress of the disease the lobe or lung is likely to become incapable of reexpansion, and bronchiectasis with putrid infection and empyema is likely to result. Thoracoplasty is indicated with stenosing bronchitis so long as the operation is done before putrid

FIGURE XII. Case IV. Following second stage of thoracoplasty cavity closed and sputum disappeared. General condition excellent.

infection with sputum retention has occurred. Once this condition has been reached, resection offers the patient his only chance. Patients whose symptoms suggest tracheo-bronchial involvement should always be examined with the bronchoscope before any collapse therapy is started. Wheeze is the symptom most commonly suggesting bronchial disease. Positive sputum without obvious cause in the lungs, severe cough with sputum which is difficult to raise, lobar atelectasis or symptoms out of proportion to the parenchymatous disease are all suggestive and should indicate bronchoscopy. Active ulceration may be treated by local applications of silver nitrate and dilatation of bronchial strictures may help to overcome sputum retention.

Bronschoscopy is always indicated if positive sputum persists after apparently successful cavity closure, and if ulceration is found sputum conversion may follow local treatment of the ulcers.

The collapse methods are established on a firm base of practical experience and will control a high proportion of cavernous lesions, but there remains a residue of patients with tension cavities in whose treatment

collapse is likely to fail, with cavities still open after thoracoplasty, with bronchostenosis and bronchiectasis, with massive tuberculomata, and with other rare conditions unsuitable for collapse. For these patients drainage of cavities or resection of the diseased lung may be necessary.

MONALDI'S SUCTION DRAINAGE.

Monaldi's suction drainage may occasionally result in the permanent obliteration of a large cavity with sputum conversion, but as a rule when the tube is withdrawn the cavity reopens. With large cavities a period of suction drainage may be a valuable preliminary to thoracoplasty and the method is worth trying for cavities that persist after thoracoplasty.

OPEN CAVERNOSTOMY.

Open cavernostomy is sometimes used for these unclosed cavities, and Eloesser has recently reported a series of twenty-four cases in which cavernostomy was adopted with eighteen successful cavity closures.

PULMONARY RESECTION.

Resection offers the only chance of relief to the patient with bronchostenosis complicated by putrid infection. It has been used, and may prove to be the method of choice, for cavities that have failed to close after adequate thoracoplasty, and for tuberculomata, and for bronchiectasis complicating tuberculosis. Although resection has been used as a deliberate alternative to thoracoplasty in a few cases, it is unlikely that it will be preferred to thoracoplasty, except in the presence of special indications that are at present too debatable for discussion on this occasion.

When empyema complicates pulmonary tuberculosis the infection may be purely tuberculous or there may be secondary infection by mixed pyogenic organisms. A broncho-pleural fistula may or may not be present, and the underlying lung may be fairly normal and suitable for reexpansion or so grossly diseased that reexpansion would be dangerous. Too many problems are presented for discussion at this time. Treatment is based on the principles of aspiration with or without lavage, drainage, and obliteration of the pleural cavity by thoracoplasty, Schede's operation and muscle transplants.

DISCUSSION.

M. P. SUSMAN (Sydney): I agree with most of Mr. Brown's remarks, but I have some points to discuss and some suggestions to make. I disagree with his opinion that artificial pneumothorax is simple and safe. From the moment of induction until the day on which reexpansion of the lung is complete, the patient may suffer from a number of complications, some of which are more serious than the original disease. It is true that most of these complications occur with an inefficient pneumothorax, but they do occur even with a satisfactory one. It is also true that the incidence of these complications in no way overshadows the great benefit that the majority of patients obtain from the procedure, but that is no reason to minimize the possible risks. I have lost two patients between stages of thoracoplasty from complications of pneumothorax of the opposite side. For internal pneumonolysis I prefer to make one opening in the axillary area and one just above and behind the angle of the scapula, with the arm well forward, rather than two in the axilla. I know that with the foroblique telescope the two axillary punctures are usually satisfactory, but one misses the advantage, on interchanging the telescope and cautery, of having two distinct approaches to the adhesions.

Thoracoplasty still remains the great standby for chronic fibro-cavernous tuberculosis. I am not at all convinced that a Semb apicolysis should be done as a routine, as advocated by Overholt, Price-Thomas and many other experienced surgeons. I find that by doing an anterior stage operation to begin with and removing not only the

front of the rib proper, but also the cartilages of the upper three ribs right to the sternum, the percentage of cavity closures is as high as with extrafascial apicolysis. This anterior stage makes the upper posterior stage easier both for the patient and surgeon. The disadvantages of apicolysis have not been sufficiently stressed; although I found that it does not increase the death rate, I did find that it increased morbidity and prolonged the convalescence, and also that, by pushing the cavity to a lower level, far from aiding closure, it has sometimes made it necessary to resect more of the lower ribs than was expected at first.

Tuberculous empyema is a horror which is increasing with the greater use of artificial pneumothorax and internal pneumonolysis. Many cases can be managed satisfactorily by repeated aspirations with or without lavage and instillations, but for many patients, particularly those with pyogenic infection and those with uncontrolled disease in the collapsed lung, nothing short of complete rib removal will suffice. Some will need resection of parietal pleura as well (Schede), but I want to stress the view that in a large number the whole pleural space can be completely obliterated by wide rib resection alone. Drainage should be instituted promptly not only for established mixed infection, but for an evident broncho-pleural fistula, even if no pyogenic contamination is present. The site of drainage should be low and antero-lateral, and the skin flap method of Eloesser is admirable. Thoracoplasty should be started as soon as possible. I have done the first stage of the thoracoplasty and the drainage operation at the one sitting in a patient in good condition. I have not yet deliberately resected a tuberculous lobe or lung, but I have twice removed a lobe which was later proven tuberculous. Both patients survived operation to die later with spread of the disease. But encouraging reports from abroad suggest that this operation has a distinct place in the treatment of selected cases of tuberculosis.

H. W. WUNDERLY (Adelaide): If you accept the premise that tuberculous tissue under tension will not heal, then in no sphere of medical practice does the physician depend more on the collaboration of his surgical colleague than in the treatment of pulmonary tuberculosis.

Of the first two hundred cases of pulmonary tuberculosis which have remained for treatment in the military hospital to which I am attached, 124 have required some form of collapse therapy. The use of the word "collapse" in describing this form of treatment is unfortunate; a better term would be "relaxation" therapy, for its primary object is not to apply pressure, but to relieve tension. Of these 124 cases, an artificial pneumothorax was induced in 104, there being a completely free pleural space in only 14. In 13 induction was impossible because of complete symphysis of the pleura. Of the 90 cases complicated by adhesions, almost 80 have been considered suitable for internal pneumolysis. In some instances this has been combined with phrenic crush, either alone or with pneumoperitoneum. Bilateral disease and tuberculosis of the larynx were not regarded as contraindications, but patients with tuberculous pneumonia, tuberculous enteritis, tracheo-bronchitis, severe bronchitis, emphysema and bronchiectasis were not given this form of treatment. When it has not been possible to close the cavities and when the collapse is contraselective, the pneumothorax has been abandoned.

The complications of internal pneumolysis have been very few, and in about two-thirds of the cases in which this treatment was adopted the immediate results look satisfactory. In some it has not been possible to divide all the adhesions and the cavities remain open. In others, although all the adhesions appear to have been severed, the cavity still remains patent. In several there is complete atelectasis of the affected lobe and even of the whole lung, with the cavity or cavities still plainly visible. It is difficult to offer a satisfactory explanation of how a cavity can remain uncollapsed in a completely atelectatic lobe or lung. It would appear that this condition requires a different form of treatment, either a thoracoplasty, a lobectomy or a pneumonectomy. These procedures, as the opening speaker indicated, should be used when endobronchial disease or stenosis of the bronchi has become complicated by bronchiectasis.

A second complication is tuberculous empyema. This condition is always serious and occurs both in cases in which adhesions have been divided and in those in which internal pneumolysis has not been carried out. A discussion of the best form of treatment to adopt could occupy a whole session, and I shall not attempt it. Some good results are obtained with repeated aspiration and lavage, and anything which helps the obliteration of the pleural space by reexpansion of the lung should be given a trial. Most authorities are agreed that the pneumothorax should be abandoned. The answer to the question, "What is the best form of treatment?" must lie somewhere between that advocated by the late Dr. Chandler in one of his last publications—to leave the patients alone—and the practice of many thoracic surgeons who think the empyema should be drained and, almost immediately, the space obliterated by thoracoplasty or some modification. It is important not to delay too long before seeking

the assistance of a thoracic surgeon. As soon as the diagnosis is made he should be consulted. The task has become far more difficult when the patient is suffering from advanced toxæmia. The incidence of this dangerous condition will be diminished if every pneumothorax producing contraselective collapse is abandoned quite early.

The original Sauerbruch extrapleural thoracoplasty produced relaxation in the latero-medial direction, but often left the apex under tension. The addition of Semb's apicolysis, or of a preliminary anterior stage, relieves this apical tension. As the result of these procedures this part of the lung is given a better chance to heal. Just as Sauerbruch's original operation has been modified and extended, so we must add to the indications for its use. We must cease to make it available only for the safe "chronics" and extend it to the "relapsing chronics" and even to some of the "slipping chronics", for it can be life-saving.

I should like to stress the need for greater use of the bronchoscope in all these major surgical procedures. The thoracic surgeon needs to be an experienced physician, a well-trained surgeon and an expert endoscopist. The incidence of post-operative atelectasis and spread of disease to previously unaffected tissue can be lessened by blocking off the main bronchi during the operation, and the use of the bronchoscope, combined with suction at the end of the resection, will remove much mucus and infected material.

Most of the procedures which have been described this evening are tackling the disease at the wrong end. In the very near future it should be possible for physicians to see the patients so early that cavities or adhesions will form but rarely. With the introduction of universal radiography most lesions should be detected when they are minimal. The last word has not been said about what it is best to do with these minimal lesions, but the opinion is growing that the safest form of treatment is the shallow pneumothorax. In this way most adhesions will be prevented from forming and most lesions will be discovered before they have gone on to cavitation.

F. J. COLAHAN (Melbourne): There is one aspect of pulmonary tuberculosis that I should like to bring before this meeting, and that is the question of bronchial tuberculosis. I think this is an important matter for several reasons: (*a*) because it is of interest to both physicians and surgeons concerned in the treatment of this disease; (*b*) because it is a serious complication, occurring in approximately 11% of cases of pulmonary tuberculosis; (*c*) because of the problems it presents in regard to its management and treatment.

Endobronchial tuberculosis may present itself as a primary condition until such time as ulceration and spillage are sufficient to cause pulmonary involvement, or it may be secondary to more deeply seated parenchymal disease. In the early stages the lesion is associated with swelling and œdema of the affected part of the bronchus, whilst later, after ulceration and fibrosis have occurred, fibro-stenosis of the bronchus results. It is thus evident that during all stages there is some degree of obstruction present. If stenosis is of severe degree, there follow those baleful complications, namely, obstructive emphysema, atelectasis and bronchiectasis.

The management of bronchial tuberculosis presents problems, many of which are not yet solved. In the early stages, before fibrosis and stenosis are pronounced, good results are achieved by the topical application of a 30% solution of silver nitrate, healing occurring in a large percentage of cases. Pneumothorax, induced either in ignorance of a bronchial lesion or in full knowledge thereof, has not produced very favourable results. The mortality rate with this form of collapse has been in the vicinity of 33%, mainly as a result of empyema, bronchial fistula and unexpanded lung. It is generally recognized and accepted that pneumothorax in the presence of endobronchial disease, either actively ulcerative or stenotic, is inadvisable and contra-indicated. Thoracoplasty produces on the whole more satisfactory collapse and control of the parenchymal lesions, and provided the stenosis is not of maximal degree and associated with bronchiectasis, is reasonably satisfactory. The mortality rate associated with thoracoplasty is about 8% and conversion of sputum about 65%. For those patients with localized or unilateral disease, especially with high-degree stenosis and return of secretions, some form of pulmonary resection or pneumonectomy is indicated. With improved technique in anæsthesia and in operative detail, this offers a prospect of cure or of arrest of the disease when no other treatment would be possible, and recent figures indicate this to be the method of choice in selected cases. It may not be extravagant to suggest that all patients with pulmonary tuberculosis, especially those with a persistent wheeze or evidence of atelectasis, should be submitted to bronchoscopy before artificial pneumothorax or thoracoplasty is performed.

HILARY ROCHE (Melbourne): Closed suction drainage of tuberculous lung cavities was first tried by Eloesser in San Francisco in 1937. The results were unsatisfactory. Monaldi in Rome, in 1938, made further trials with encouraging results. The effects of suction drainage on the cavity are twofold: (i) It overcomes the mechanical factors which tend to keep cavities distended. (ii) The caseous lining membrane is

removed and replaced by clean granulation tissue. With response to treatment, there is usually a marked improvement in the general condition, with relief of cough and other symptoms.

The method must be used only when artificial pneumothorax is impracticable. In the first place, the ideal indication is the isolated thin-walled cavity, at least three centimetres in diameter, with single draining bronchus, showing some stenosis and with no other pulmonary lesion. Such an ideal indication is rarely found. Secondly, the method may be used as a preliminary to thoracoplasty in "tension" cavities and possibly in some large atmospheric pressure type cavities. Thirdly, it may be used as a palliative: (*a*) in bilateral disease, with a view ultimately to thoracoplasty, at least on one side; (*b*) in the presence of cavities at the apex of the lower lobe in conjunction with phrenic paralysis; (*c*) in adolescence or in the treatment of patients over fifty-five years of age.

Contraindications may be absolute or relative. The absolute contraindications are (*a*) free pleural space, (*b*) acute cavity formation, (*c*) extensive exudative disease. A relative contraindication is hæmoptysis: the drainage may be instituted after bleeding ceases.

Closed suction drainage may be used in association with other treatment. Ipsilateral phrenic paralysis (crushing of nerve) is commonly used. This helps relaxation of the lung, may encourage closure of the draining bronchus, and helps substitution of the cavity space. Any kind of special treatment may be carried out on the opposite lung.

As a preliminary to operation, if the pleura is not firmly adherent at the projected site of entry, adhesions must be produced artificially. This is best done by intrapleural injections of five to ten minims of a 10% solution of silver nitrate. The cavity must be localized radiologically by postero-anterior and lateral views. Tomography is most helpful. The type of cavity should be ascertained by pressure readings. The bronchial communications may be studied by the transparietal instillation of a small quantity of lipiodol.

During operation the patient is recumbent on the X-ray screening table. As a rule, the cavity is approached from the front, but if it is right at the back the posterior entry may be used. Usually the central ray technique of Monaldi is followed. Occasionally, especially if thoracoplasty is likely to be required later on, an oblique approach can be made. The slides shown demonstrate the Monaldi trocar and the stages of the operation. It is essential that the catheter should be firmly fixed.

The cavity is aspirated by means of a syringe for the first twenty-four hours. Regular suction is then instituted. It is customary to carry on with the suction during most of the patient's waking hours. In Switzerland and at the Austin Hospital I have obtained suction by means of electric pumps. By means of the apparatus shown on the slide, the pressure can be controlled in each individual case.

When the cavity secretions are consistently "negative" for tubercle bacilli on cultural examination, and when the cavity can no longer be clearly demonstrated by radiological methods, the treatment may be terminated. A successful result may be obtained within three to four months. The radiological methods employed are cavernography (instillation of lipiodol down the catheter) and tomography. Phrenic paralysis may be induced before the catheter is removed.

Several complications must be mentioned. In the first place the effects of possible cerebral air embolism may be minimized by keeping the patient's head low while on the X-ray table. Secondly, in regard to hæmorrhage, I encountered one very severe hæmorrhage on introducing the trocar. The patient developed a tuberculous aspiration bronchopneumonia from which he eventually died. Another patient died three days after beginning the treatment. At autopsy it was found that the catheter had been in contact with an aneurysm of Rasmussen, which had ruptured. Empyema will develop unless there are firm pleural adhesions at the site of puncture. Secondary infection of the track is common, but is rarely of any serious importance. Fistula is rare; usually there is no evidence of any tubercularization of the track. Aggravation of other lesions may occur. The suction causes a vasodilatation in the lung surrounding the cavity. This may predispose to "spreads" in this area. Further, occasionally cavities in adjacent parts of the lung may enlarge.

Permanent healing is dependent on the permanent obliteration of the bronchial communications of the cavity. The introduction of an operating cavernoscope should enable the development of some successful method of occluding the cavities' outlets under direct vision. Until such artificial occlusion is possible, the results will be disappointing and the use of suction drainage for tuberculous lung cavities will have a very limited scope. The method, however, has been most valuable in enabling us to obtain a better understanding of the pathogenesis and healing of tuberculous lung cavities.

A COMPARISON OF THE TENSILE STRENGTHS OF IODINE STERILIZED AND HEAT STERILIZED CATGUT SUTURES.[1]

By PHYLLIS M. ROUNTREE,
From the Fairfax Institute of Pathology, Royal Prince Alfred Hospital, Sydney.

VARIOUS methods are available for the production of bacteriologically sterile catgut sutures. Those in common use involve either the treatment of the sutures with iodine solutions (the method recommended by Bulloch, Lampitt and Bushill[(1)]) or the sterilization of the sutures by heat while in anhydrous chemicals—for example, hydrocarbons of high boiling point. The iodine method is used by many hospitals in this country, and Williams[(2)] describes in detail the technique to be employed and the precautions taken in the use of this method. The heat sterilization technique is used in the commercial production of individually tubed sutures. It is generally recognized that both methods, when adequately controlled, can be relied upon for the production of sterile sutures (and the main emphasis in the preparation of catgut sutures has been upon their sterility).

The sterilization processes to which the catgut is subjected give rise to changes in the physical and chemical character of the original raw material. A valuable criterion of these changes is the alteration in tensile strength of the gut. In the iodine method, loss of strength is considered by Lampitt and Bushill to be due to the formation of hydriodic acid during sterilization, and with the physical heat method the loss of strength is ascribed to the action of the heat on the collagen fibres of which the gut consists. The basic problem of catgut manufacture is the production of a sterile suture which at the same time retains sufficient tensile strength.

Since in a study of the literature no explicit information could be found on the relative tensile strengths of heat and iodine sterilized sutures, this investigation was undertaken.

MATERIAL AND METHODS.

The catgut used was of the plain type and came from one source. It comprised five sizes—namely, 000, 00, 0, 1 and 2. There are considerable variations in the strength of individual sutures and of batches of sutures prepared under identical conditions, owing chiefly to the variable nature of the raw material. Attempts were made to minimize the effects of these variations as much as possible, firstly, by using for each size material from the same batch, and, secondly, by taking readings on samples sufficiently large to give statistically significant results. The sutures were in lengths of five feet six inches, and their size to the nearest thousandth of an inch was gauged before sterilization, after sterilization and storage, three readings being made on each suture.

Twenty sutures of each size were retained untreated to serve as controls.

Twenty-five sutures of each size were sterilized by heat. In the method used the sutures were wound on fibre spools, each suture was individually

[1] Accepted for publication on March 7, 1945.

tubed, all moisture was removed by drying in a hot air oven, and then the sutures were sterilized by heating at 158° to 159° C. for one hour in a hydrocarbon of high boiling point. On removal of the spools from the sterilizer, all further processes were carried out under aseptic conditions, the sterilizing medium being drained off, alcoholic storage fluid added and the tubes sealed immediately.

Eighty sutures were treated by the iodine-without-glycerol method. These were wound on glass spools, placed for nine days in the iodine solution, then washed in 98% methylated spirits containing 0·4% mercuric biniodide. The wash solution was changed on three successive days, samples were taken for sterility tests, and the remainder of the spools were left in the solution until they were withdrawn at intervals for tensile strength determinations. From the heat-sterilized batches five tubes of each size were taken for sterility tests. These tests were performed by the standard method of the British Therapeutic Substances Regulations (1931), cooked meat medium being used for cultural examinations.

Determinations of tensile strength were made on a machine which applies a constantly increasing tension to the suture and automatically registers, to the nearest quarter of a pound, the weight at which the suture breaks. If the suture is knotted, the breakage always occurs at the knot—that is, the weakest point of the suture. Accordingly, readings were made on the knotted sutures. Four or five readings were made on each individual suture. For the sake of ease in the computation of the results, the readings were taken to the nearest half pound. To eliminate, as far as possible, errors due to personal variability in the reading of the results, all determinations were made by one person.

RESULTS.

Sterility.

No growth was detected after fourteen days' incubation of any of the samples taken for sterility tests.

Tensile Strength.

Table I sets out the results of the readings taken on the raw sutures, on the iodine-sterilized sutures after one month's and six months' storage, and on the heat-sterilized sutures after three months' storage. It includes, for

TABLE I.

Tensile Strengths in Pounds of Raw Catgut and of Catgut Sterilized by Heat and Iodine.

Size.	Treatment.	Number of Readings.	Mean Breaking Point.	Standard Deviation.
000	Untreated	80	4·23 ± 0·07	0·63 ± 0·05
	Iodine (1 month)	100	3·75 ± 0·06	0·59 ± 0·05
	Iodine (6 months)	25	3·91 ± 0·1	0·69 ± 0·07
	Heat (3 months)	80	2·59 ± 0·05	0·48 ± 0·04
00	Untreated	100	6·87 ± 0·07	0·74 ± 0·05
	Iodine (1 month)	100	5·48 ± 0·07	0·68 ± 0·05
	Iodine (6 months)	50	5·78 ± 0·11	0·78 ± 0·08
	Heat (3 months)	80	3·98 ± 0·06	0·53 ± 0·04
0	Untreated	80	8·89 ± 0·14	1·22 ± 0·1
	Iodine (1 month)	100	8·31 ± 0·11	1·12 ± 0·08
	Iodine (6 months)	100	8·97 ± 0·12	1·23 ± 0·08
	Heat (3 months)	100	5·73 ± 0·08	0·81 ± 0·06
1	Untreated	80	11·3 ± 0·12	1·12 ± 0·08
	Iodine (1 month)	100	10·38 ± 0·09	0·92 ± 0·06
	Iodine (6 months)	25	10·56 ± 0·17	0·84 ± 0·12
	Heat (3 months)	80	7·94 ± 0·11	1·01 ± 0·08
	Untreated	80	12·63 ± 0·15	1·35 ± 0·11
	Iodine (1 month)	100	12·38 ± 0·11	1·12 ± 0·08
	Iodine (6 months)	25	12·12 ± 0·2	1·0 ± 0·14
	Heat (3 months)	80	9·32 ± 0·11	1·01 ± 0·08

each type of suture, the number of readings taken, the mean breaking point in pounds and the standard error of the mean, and the standard deviation and its standard error.

It was not possible to arrange an equal number of readings on every type of suture, but the number of readings obtained gives a series sufficiently large to minimize the effect of the variations in the gut. The coefficients of variation were calculated for each type of suture, but are omitted from the table for space reasons; they are of comparable orders of magnitude for all types of suture of each size. The three months' interval allowed for storage of the heat-sterilized gut was selected from previous knowledge that this interval allows an adequate time for the stabilization of the tensile strength. The iodine-sterilized gut was tested one month after treatment and after a further five months' storage in order to determine if there had been any loss of strength during storage.

TABLE II.

Differences in Tensile Strength in Pounds of Raw Catgut and of Catgut Sterilized by Heat and by Iodine.

Size.	Treatment.	Mean Difference in Pounds.
000	Raw v. heat sterilized	*+1·64* ±0·08
	Raw v. iodine (1 month)	*+0·48* ±0·09
	Raw v. iodine (6 months)	*+0·32* ±0·12
	Iodine (1 month) v. heat	*+1·16* ±0·08
	Iodine (1 month) v. iodine (6 months)	−0·16 ±0·11
00	Raw v. heat sterilized	*+2·89* ±0·09
	Raw v. iodine (1 month)	*+1·39* ±0·1
	Raw v. iodine (6 months)	*+1·09* ±0·12
	Iodine (1 month) v. heat	*+1·50* ±0·08
	Iodine (1 month) v. iodine (6 months)	−0·30 ±0·13
0	Raw v. heat	*+3·16* ±0·16
	Raw v. iodine (1 month)	*+0·58* ±0·18
	Raw v. iodine (6 months)	−0·08 ±0·18
	Iodine (1 month) v. heat	*+2·58* ±0·14
	Iodine (1 month) v. iodine (6 months)	*−0·66* ±0·15
1	Raw v. heat	*+3·36* ±0·16
	Raw v. iodine (1 month)	*+0·92* ±0·15
	Raw v. iodine (6 months)	*+0·74* ±0·21
	Iodine (1 month) v. heat	*+2·44* ±0·14
	Iodine (1 month) v. iodine (6 months)	−0·18 ±0·19
2	Raw v. heat	*+3·31* ±0·18
	Raw v. iodine (1 month)	+0·25 ±0·18
	Raw v. iodine (6 months)	+0·51 ±0·25
	Iodine (1 month) v. heat	*+3·06* ±0·16
	Iodine (1 month) v. iodine (6 months)	+0·26 ±0·23

Table II gives the calculations of the differences in tensile strength of the variously treated five sizes of suture. Significant differences are printed in italics. In order to give absolutely comparable results, the comparison between the iodine and heat-sterilized sutures should be made with samples which have been stored for the same length of time. In the original plan of the investigation it was intended to make readings on iodine sutures which had been stored for three months, but owing to an accident it was impossible to do this. However, if the results are referred to the strength of the original raw material, a satisfactory picture of what has occurred in the sterilizing and storage process can be obtained.

The results show that for all sizes there is a significant loss of strength during the heat sterilization process. In all sizes except size 2 there is a significant loss of strength with iodine sterilization. The loss of strength is greater in the heat-treated than in the iodine-treated sutures. It will also be noted that there is no constant proportional relationship between the diameter of the suture and the amount of strength lost.

The differences between the iodine sutures stored for one month and six months were examined. The variance of the material increases with its

diameter and it is not legitimate to pool the whole five differences and compare the pooled difference with a single standard error. Sizes 0, 1 and 2 are comparable for standard deviation and, if the method of weighted mean squares is used, the mean difference of these three sizes is 0·19 with an error of 0·12, which is not significant. Sizes 000 and 00 have comparable variances and combining their differences gives a mean difference of 0·23 ± 0·095, which is significant. It can be concluded that any difference between the one-month and six-months sutures is of doubtful significance. Provided that the iodine sterilizing solution is thoroughly removed from the sutures, no deterioration apparently takes place during storage over a considerable period of time.

Change in Diameter of Sutures.

Gauging of the diameter of the gut before sterilization and at the time when the tensile strength determinations were made afforded an opportunity to observe the extent of the change in size during sterilization and storage. Table III gives the average of thirty readings for each size of suture to the

TABLE III.

Diameter of Catgut Before and After Sterilization and Storage (in Thousandths of an Inch).

Size.	Type of Suture.		
	Raw.	Heat-Sterilized.	Iodine-Sterilized.
000	12	12	12
00	15	17	16
0	18	21	19
1	20	23	23
2	23	27	27

nearest thousandth of an inch. It will be seen that there is a definite increase in diameter which in the coarser sutures amounts to an increase of one size. In the case of the heat-sterilized sutures this is due to the absorption by the gut of the storage solution. When heat-sterilized size 1 sutures were dried by heating to 80° C. in a flask attached to a vacuum pump, approximately 18% by weight of the suture was lost; this indicates that the major part of the increase in size can be attributed to the absorption of alcohol from the tubing fluid.

DISCUSSION.

The loss of tensile strength shown to occur during the production of sterile surgical sutures by the methods used in this investigation is a statistically significant one, and is greater for heat-processed than for iodine-treated catgut. It is the experience of catgut manufacturers using a heat sterilization process that there is a narrow margin between a time-temperature treatment which produces a sterile suture retaining sufficient tensile strength for surgical use and a time-temperature treatment which renders the catgut useless because of excessive heat. On the other hand, a lower temperature or shorter time, while not affecting the tensile strength, cannot be relied upon to produce consistently sterile sutures. The time-temperature treatment used in the experiment described can be relied upon to produce sterility, but does affect tensile strength more than the iodine treatment, although not enough to interfere with the surgical efficiency of the sutures. In the routine testing of sterility of catgut sutures, 5,000 sutures prepared by the time-temperature treatment used in this investigation have been tested without the discovery of

any evidence of under-sterilization. In view of the above considerations of the effect of heat on tensile strength, it is clearly necessary that in the testing of heat-sterilized catgut the tensile strength as well as the sterility should be controlled.

In both types of suture concerned in this investigation sufficient tensile strength is retained for the products to be surgically acceptable, and the choice between the two types should be made on grounds other than their tensile strength. While the iodine treatment, when properly applied, can be relied upon to sterilize catgut sutures, there are, in the use of this method, dangers of contamination in the handling of the sutures in bulk after sterilization. When a number of sutures are rolled on one spool, portion of the gut may be cut from the spool during an operation, and the remainder, possibly contaminated during this handling, returned to a storage solution which is not bactericidal and in which resistant spores may persist indefinitely. Similarly, in the transfer of spools from one wash solution to another or to storage solution there are opportunities for contamination. The sterility of iodine-treated sutures should therefore be rigidly controlled both after the iodine treatment and during their use in the operating theatre. Under conditions in which this bacteriological control is not possible, it is not advisable to use iodine-treated sutures. On the other hand, individually tubed heat-sterilized sutures, particularly when accompanied by a declaration of sterility in accordance with the requirements of the British Therapeutic Substances Regulations (1931), provide a greater measure of security with regard to sterility.

SUMMARY.

1. There was a statistically significant loss in tensile strength as a result of sterilization of catgut by both the iodine and the heat treatments investigated.

2. The loss was greater in the heat-sterilized than in the iodine-sterilized sutures.

3. Both types of sutures investigated are surgically adequate.

4. There was no significant change in tensile strength of iodine-sterilized sutures during a storage period of five months. Heat-sterilized sutures behave similarly.

5. During sterilization and storage of both iodine- and heat-treated sutures there was an increase in diameter, amounting to an increase of one size in coarser sutures.

6. The reasons for the preferability of individually tubed heat-sterilized sutures are discussed.

ACKNOWLEDGEMENT.

My thanks are due to Miss Helen Turner for assistance with portion of the statistical calculations.

REFERENCES.

(1) L. Bulloch, L. H. Lampitt and J. H. Bushill: "The Preparation of Catgut for Surgical Use", Medical Research Council, Special Report Series, Number 138.

(2) F. E. Williams: "The Preparation and Testing of Surgical Catgut", *The Medical Journal of Australia*, July, 1936, page 39.

Case Reports.

AN OSTEOTOMY TO CORRECT RIGHT-ANGLE DEFORMITY.[1]

By JOHN HOETS,
Sydney.

C.R., AGED forty-two years, had suffered from acute infective arthritis in childhood resulting in complete bony ankylosis of both hip joints in flexion to a right angle. He was able to walk with extreme difficulty, moving his legs from the knees and with his body horizontal. He sat, of course, normally. He was shy and diffident of meeting people and very miserable. His one desire was to have something done to allow him to stand erect. As he had progressed for so long without hip movement, this loss did not seem to worry him. His people were in an hotel business and his great wish was to be able to stand up behind the bar.

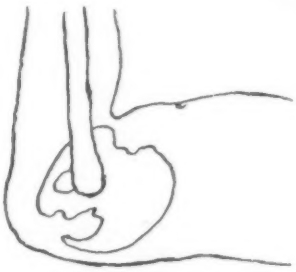


FIGURE I.

The problem was to extend from the right angle on both sides and to avoid circulatory danger from the over-stretching of vessels. The accompanying diagrams show the osteotomy as carried out; the shortening of the femora allowed full extension without any undue disturbance of circulation. The patient was comfortable in a double plaster spica for eight weeks, when it was removed and clinically sound union was found. He was put out over the foot of the bed, holding onto the uprights of the Balkan frame, for a few minutes at the end of the eleventh week and the time was gradually increased until he got accustomed to standing erect. He began to walk holding onto a cross bed table, resting elbows and gripping the far edge. This is an excellent method of teaching a patient to walk. Crutches were used at the end of three months. He is now quite comfortable, stands without support, but walks as yet with crutches except for a few steps. The most interesting change is in his outlook on life; he appears bright and happy, and has lost the shy nervous manner.

FIGURE II.

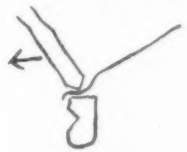


FIGURE III.

The operation was carried out on a portable traction apparatus. The thighs were vertical as in Figure I, and the legs from the knees, flexed at right angles, were bandaged to the top bars of the table (horizontal). The rectangular socket for the reception of the shaped end of distal fragment was cut first to the depth of about one inch. There is plenty of thickness here, as the expansion of the shaft by the lesser trochanter provides bony depth. The lines of incisions to shape the proximal ends of distal fragment were marked by drill holes and then completed with narrow osteotome (Figure II). The leg was freed from the overhead bar and a skid was placed as shown in Figure III. On gentle extension the distal fragment slid into its prepared position without difficulty (Figure IV) and required no other fixation than the suturing of soft tissues and application of double plaster spica when both sides had been completed.

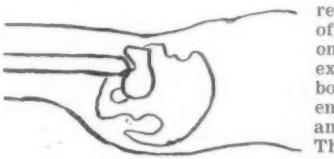


FIGURE IV.

There was no great shock, and the patient's condition gave no anxiety.

[1] Accepted for publication on March 3, 1945.

PARATHYREOID TUMOUR: REPORT OF A CASE AND SURGICAL DISCUSSION.[1]

By HUGH R. G. POATE,
Group Captain, Royal Australian Air Force; Consulting Surgeon to an Australian Base Hospital,

AND

A. C. CHRISTIE,
Captain, Australian Army Medical Corps.

Clinical History.

ABOUT two years ago (October, 1942) the patient, Gunner M., aged twenty-four years, single, passed a calculus *per urethram*, and at the time of investigation had had intermittent attacks of right-sided renal colic since. Over the previous four months he had complained of pain in his knees, back, ankles and epigastrium, pain in the last-mentioned site not being related to food. Polydipsia and diurnal polyuria developed about three months before he came under investigation and were then very severe. For about one month he had complained of blurred vision. Besides a continuous feeling of tiredness and weakness over the last twelve months, he stated he had noticed a change in his disposition in that he now became "nervy and shaky" at the least provocation. Anorexia had been present over the previous six months. Apart from rheumatic fever eight years earlier he had had no illness of any consequence.

When examined in June, 1944, he was found to have a systolic blood pressure of 215 millimetres of mercury and a diastolic pressure of 140 millimetres. A soft mitral systolic murmur not propagated to the axilla and an accentuated aortic second sound were detected on auscultation of the precordium. Retinoscopy revealed no abnormality of the fundi.

Microscopic examination of the centrifuged urinary deposit revealed a heavy deposit of amorphous phosphates and an occasional hyalogranular and cellular cast. The fasting blood urea content was 53 milligrammes *per centum*, and the urea concentration test gave the following information:

	Volume. (Cubic Centimetres.)	Specific Gravity.	Urea *per Centum.*
Urine before 15 grammes of urea ..	225	1·010	0·82
Urine 1 hour after urea	78	1·011	1·05
Urine 2 hours after urea	85	1·011	0·97
Urine 3 hours after urea	140	1·008	0·85
Urine 4 hours after urea	45	1·010	0·92

All specimens contained a trace of albumin (as shown by the salicyl-sulphonic acid test).

The fasting serum calcium content was 17·5 milligrammes *per centum*, the serum chloride content was 570 milligrammes *per centum*, the serum protein content was 8·4 grammes *per centum*, and the blood serum phosphorus content was 2·5 milligrammes *per centum*.

Radiological examination of the long bones, skull, vertebral column, pelvis, mandible and ribs showed no evidence of osteoporosis, although in the case of the vertebral column the radiological report referred to "some lateral wedging of the first lumbar vertebral body and diminution of the intervertebral space between the first and second lumbar vertebræ". As normal control radiographs taken at the same time and under similar photographic conditions were not made, very early osteoporotic changes cannot be excluded. The radiological picture of the arterial tree was within normal limits. A plain X-ray picture of the renal tracts suggested a small calculus in the right renal area.

Owing to technical difficulties, a modified calcium balance experiment only could be carried out. The results were as follows:

Daily intake of calcium in diet	0·92 gramme approximately
Daily urinary excretion of calcium	0·92 gramme

[1] Accepted for publication on February 9, 1945.

There was thus a negative calcium balance by the amount lost in the stools.

The red cell count was 3,500,000 cells per cubic millimetre, with a hæmoglobin level of 10·0 grammes *per centum* (colour index, 0·9).

The total leucocyte count was 14,000 cells per cubic millimetre, and the differential count as follows: neutrophile cells, 79%; lymphocytes, 18%; basophile cells, 1%; monocytes, 2%.

The Eagle flocculation test carried out on the blood serum gave no reaction. There were no abnormal electrocardiographic findings.

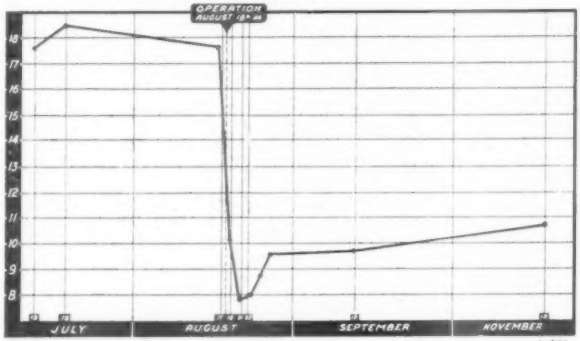
Before operation considerable difficulty was experienced in carrying out venepunctures for diagnostic purposes because of a marked increase of venous rigidity which disappeared within two weeks of operation.

The activity of the tendon reflexes in both upper and lower extremities was considerably increased, but, since operation, has diminished.

The patient's weight over a three-month period before operation varied from nine stone four pounds to nine stone ten pounds. Now (November, 1944) his weight is ten stone twelve pounds.

Operation was performed in mid-August, 1944. The technique and findings are discussed later.

The patient underwent an uneventful convalescence, and the findings of several post-operative blood serum calcium content estimations varied between 8·0 and 10·5 milligrammes *per centum* (see Graph I).

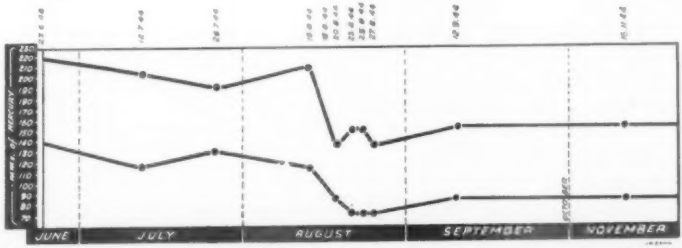


GRAPH I. Serum calcium content before and after removal of adenoma of parathyreoid.

Post-operative tetany, Chvostek's and Trousseau's signs were absent. However, subjective sensations of numbness and tingling in the extremities were complained of for several days after operation.

Two weeks after operation the blood urea content was 45 milligrammes *per centum* and the urea concentration test results were as follows:

	Volume. (Cubic Centimetres.)	Specific Gravity.	Urea *per Centum.*
Urine before 15 grammes of urea ..	230	1·008	1·17
Urine 1 hour after urea	155	1·008	1·45
Urine 2 hours after urea	80	1·009	1·32
Urine 3 hours after urea	70	1·009	1·37



GRAPH II. Blood pressure readings before and after operation. Upper curve: systolic pressure. Lower curve: diastolic pressure.

Microscopic examination of the centrifuged deposit showed an occasional granular cast and red blood cell.

The blood pressure readings both before and after operation are recorded in graphic form (see Graph II).

A further series of tests was carried out three months after operation (mid-November, 1944). These were as follows:

1. The fasting blood urea content was 56 milligrammes *per centum*.

2. Water concentration. The specific gravity and volume of the morning specimen of urine after fasting twelve hours were 1·020 and twelve ounces respectively.

3. The water dilution and excretion test gave the following results:

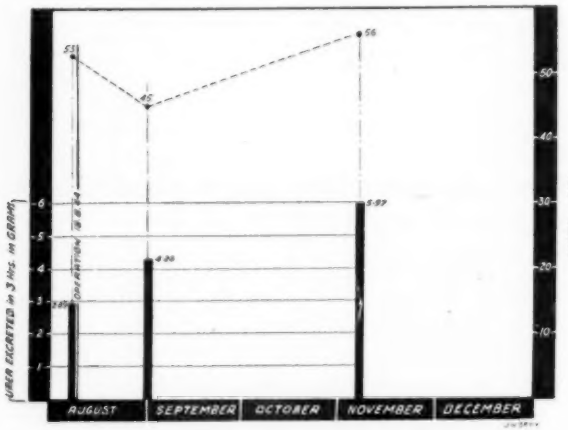
Given water (40 ounces) 7 a.m.	Volume of Urine. (Ounces.)	Specific Gravity.
8 a.m.	8	1·000
9 a.m.	16	1·000
10 a.m.	2	1·010
11 a.m.	1	1·010

4. The urea concentration test gave the following results:

	Volume. (Cubic Centimetres.)	Specific Gravity.	Urea *per Centum*.
Urine before 15 grammes of urea ..	65	1·017	2·12
Urine 1 hour after urea	85	1·016	2·32
Urine 2 hours after urea	90	1·015	2·65
Urine 3 hours after urea	55	1·018	2·92

5. The fasting serum calcium content was 10·8 milligrammes *per centum*.

The patient states that he no longer feels tired and weak, and the constant aches and pains in his limbs and back have also disappeared.



GRAPH III. Lower graph: total urea, expressed in grammes, excreted in three hours following the ingestion of 15 grammes of urea. Upper graph: pre-operative and post-operative fasting blood urea levels.

The Normal Parathyreoid Glands.

The following is a brief outline of the anatomy and histology of normal parathyreoid glands.

Anatomy.—The parathyreoid glands are two pairs of yellowish-brown ovoid or lentiform structures averaging about 5·0 to 7·0 millimetres long by 3·0 to 4·0 millimetres wide by 1·0 to 2·0 millimetres thick. The total weight varies from 0·8 to 1·2 grammes. Their position varies considerably, but they are usually closely applied to the back of the thyreoid gland.

Histology.—The normal gland consists of columns of epithelial cells separated by numerous sinusoid blood channels.

There are three types of epithelial cell found in the glandular tissue classified as follows: (i) principal cells; (ii) oxyphile cells: (*a*) small dark type, (*b*) large pale type.

The principal cells are polyhedral in shape and contain vesiculated cytoplasm. Some show slight vesiculation and others gross changes until completely dropsical or ballooned cells filled with glycogen are formed (referred to by some writers as *Wasserhelle* cells). The average size is 6μ to 15μ, and in hæmatoxylin-eosin preparations the cell stains a blue-purple. The nuclei are 4μ to 5μ in diameter and usually lightly stained, but may be dark in the smaller cells. The cells sometimes bound alveolar spaces filled with oxyphile coagulum.

The pale oxyphile cells vary from 12μ to 15μ in diameter. Their cytoplasm consists of evenly distributed small spherical granules staining a bright warm red in hæmatoxylin-eosin preparations. The nuclei average 4μ to 5μ in diameter and the smallest are pyknotic. Sometimes these cells surround alveolar spaces filled with acidophile coagulum.

The dark oxyphile cells average 9μ in diameter and possess dense granular cytoplasm staining deep red or purplish-red in hæmatoxylin-eosin preparations. The nuclei average 3μ to 5μ in diameter and are deeply stained.

Pathological Report of Tumour Removed.

Macroscopic Appearances.—The specimen is a spherical encapsulated soft lobulated tumour weighing 7·7 grammes and measuring 3·0 centimetres in diameter.

The capsule is broken at one point over a circular area 0·5 centimetre in diameter. On section a pale pinkish-white fleshy homogeneous surface is revealed, almost completely bisected by a central fissure which opens externally at the capsular neck.

Microscopic Appearances.—The normal parathyreoid structure is retained, except that the matrix is almost completely absent. The only cell seen is the principal cell. These cells are polygonal in shape and vary from 10μ to 15μ in diameter. The cell boundaries are easily distinguished and the cytoplasm has a homogeneous slightly basophilic tint in hæmatoxylin-eosin sections. The nuclei show considerable variation in size and texture. The majority have a loose vesiculated chromatin structure with a central nucleolus. The average nuclear diameter varies from 6μ to 11μ, but there are quite a number of small pyknotic nuclei 3μ in diameter. There are a few spaces containing oxyphile coagulum lined by principal cells arranged in columnar fashion. There are no giant nuclei, multinucleated cells or oxyphile cells to be seen.

The histological picture is that of hyperplasia.

General Comment.

The patient's history is of interest in that the underlying lesion might easily have been overlooked had not his calcium metabolism been investigated. Noad and Miller[9] report a similar case history in a male, aged twenty-two years. Briefly, their patient complained of the passage of gravel for ten years; but, unlike our patient, had radiological evidence of bony decalcification. His serum calcium content was 16 milligrammes *per centum* and his inorganic blood phosphorus content was 3·9 milligrammes *per centum*. The systolic blood pressure was 130 millimetres of mercury and the diastolic pressure 80 millimetres. The parathyreoid tumour removed measured 2·0 by 1·0 by 0·5 centimetres, and was histologically proved to be an adenoma. The patient's renal function as revealed by the urea concentration test was impaired, but after operation showed considerable improvement. In our case it is as yet too early to assess the permanent improvement, if any, in renal function.

Hunter,[8] in an extensive survey of the literature, showed clearly that in the early stages, and in fact for several years, the only symptoms complained of may not so much as give a hint that parathyreoid overactivity is the underlying cause of the trouble. He found that general weakness, lassitude, vague bone pains and nausea were common to almost all cases. Many patients, in addition, complained of polydipsia, polyuria and renal colic. However, swelling in the long bones, localized areas of bone tenderness and spontaneous fractures were late signs.

There was a marked fall in blood pressure after operation, and it is of interest to note that this fall has been sustained over a period of three and a half months after operation.

Although the renal impairment could possibly be accounted for on the basis of a diffuse renal calcinosis and the subsequent improvement due to a gradual removal of calcium from the kidneys, the immediate and sustained post-operative fall in blood pressure cannot be satisfactorily explained in this way.

It is of interest here to record Oliver's[13] findings in two fatal cases of acute hyperparathyreoidism.

In the first, a female, aged fifty-seven years, the systolic blood pressure on the patient's admission to hospital was 160 millimetres of mercury and the diastolic pressure was 100 millimetres. At autopsy the findings were, *inter alia*: (*a*) Parathyreoid glands: a single principal-cell adenoma measuring 3·8 by 1·8 centimetres in its longest dimensions

and weighing 3·8 grammes was present. (*b*) Kidneys: macroscopically the cut surfaces of both kidneys showed numerous small calcareous flecks. Microscopically there was severe tubular epithelial necrosis with deposition of calcium in the dead tissue and a moderate glomerular necrosis with deposition of calcium and occasional hyalinized glomeruli. There was intimal hyaline degeneration of the interlobular vessels with deposition of calcium in the internal elastic lamina, but without hypertrophy of the media and intimal hyaline thickening of a few glomerular afferent arterioles with

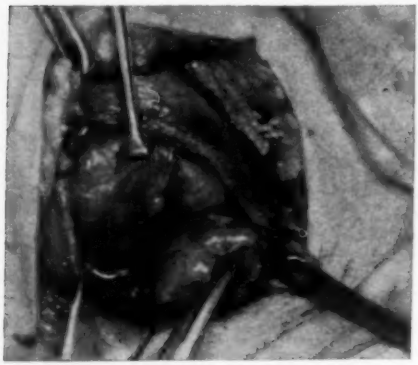


FIGURE I. Lower pole of thyreoid held up by Allis forceps. The tumour has just been lifted up from its bed and is held by the forceps alongside the Kocher's retractor which holds the undivided right infrahyoid muscles laterally.

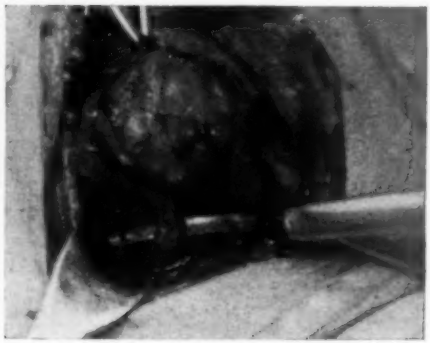


FIGURE II. The tumour, still attached by its vessels, has been lifted upward. The dissector is beneath the inferior thyreoid artery. Below and behind it is the cavity from which the tumour was enucleated medial to the fascial capsule of the thyreoid gland which was incised to allow of access.

small deposits of calcium. (*c*) In all organs sectioned there were similar vascular changes—namely, hyaline thickening of the intima and deposition of calcium in the internal elastic lamina.

The second case was that of a female, aged fifty-six years, admitted to hospital seriously ill with excessive vomiting, marked loss of weight and pain in the chest. At autopsy a principal cell adenoma of one parathyreoid gland weighing 1·4 grammes was found.

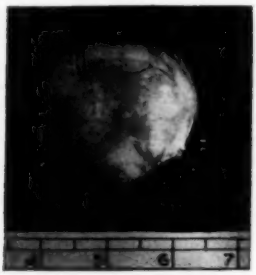


FIGURE III. The intact tumour of the right inferior parathyreoid gland.

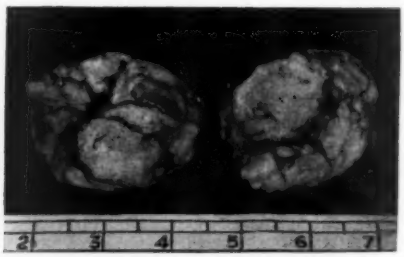


FIGURE IV. The tumour bisected, showing the characteristic central hiatus.

There were, *inter alia*, widespread necrosis and deposition of calcium in the kidneys, lungs, heart and stomach and in the vessels of nearly all the organs.

Furthermore, Albright, Baird, Cope and Bloomberg[14] recognize three types of renal lesion in hyperparathyreoidism, namely:

Type 1, characterized by calculi with pyelonephritis.

Type 2, characterized by calcium precipitates in the tubules with chronic renal damage.

Type 3, characterized by acute parathyreoid poisoning with anuria and death from an undetermined cause (? parathormone poisoning) in a few days with calcium deposits in the kidneys and in other organs, but with no chronic renal changes.

In a search of the literature at our disposal we were unable to find any reference to hypertension associated with hyperparathyreoidism and its immediate abolition following operation. Hunter[8] records the pre-operative blood pressure readings in three of his cases (systolic and diastolic pressures respectively of 140/100, 120/90 and 160/100 millimetres of mercury), but fails to record the post-operative levels. Again, in Noad and Miller's case the pre-operative reading was 130 and 80 millimetres of mercury, but the post-operative values are not recorded.

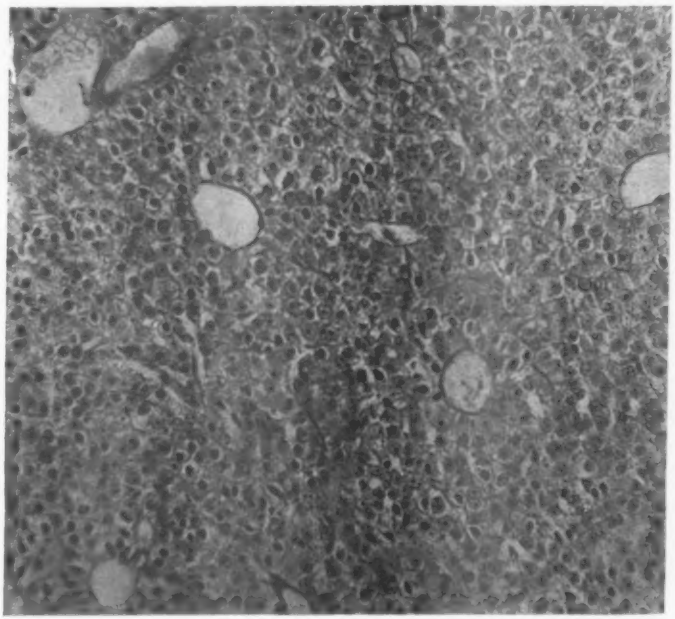


FIGURE V. The general structure of the tumour, showing cords of principal cells, some of which are arranged around vascular sinuses and others about empty spaces (in other areas these spaces contained oxyphile coagulum). Hæmatoxylin-eosin stain. × 50.

Hunter found no relationship between the size of the tumour and the blood calcium and plasma inorganic phosphorus levels. In three of his patients there were two parathyreoid tumours. It is interesting to note that in Hunter's series of thirty-seven cases (including his and those he reviewed) only five palpable tumours were present.

Of ten cases reviewed by us (four recorded by Hunter,[8] one by Mimpriss and Butler,[10] two by Gordon Taylor and Handley,[11] one by Noad and Miller referred to above, and two by Oliver[12]), seven were due to hyperplasia and three to actual adenoma of one or more parathyreoid glands.

Of the eight hyperplasias (the seven referred to above *plus* our own) six were composed essentially of principal cells and two of pale oxyphile cells. The cell type in two of the adenomata is the principal cell and in the third case the type is not stated.

Castleman and Mallory[12] have reviewed 184 cases, some his own and others from the literature up to 1935, and has classified the lesions as follows:

	Females.	Males.
Number of cases: 174	122	52
Adenomata	108	45
Hyperplasias	14	7
Total	122	52

He further tabulated the number of glands enlarged:

185 cases.			
Single glandular enlargement			146
Multiple glandular enlargement—			
2 glands	25		
3 glands	1		
4 glands	13		
		39	
Total			185

Surgical Discussion.

Because of the rarity of parathyreoid tumours their surgical approach has been attempted by very few surgeons, the majority of whom have not specialized in the minute anatomy of these glands and of this area of the neck.

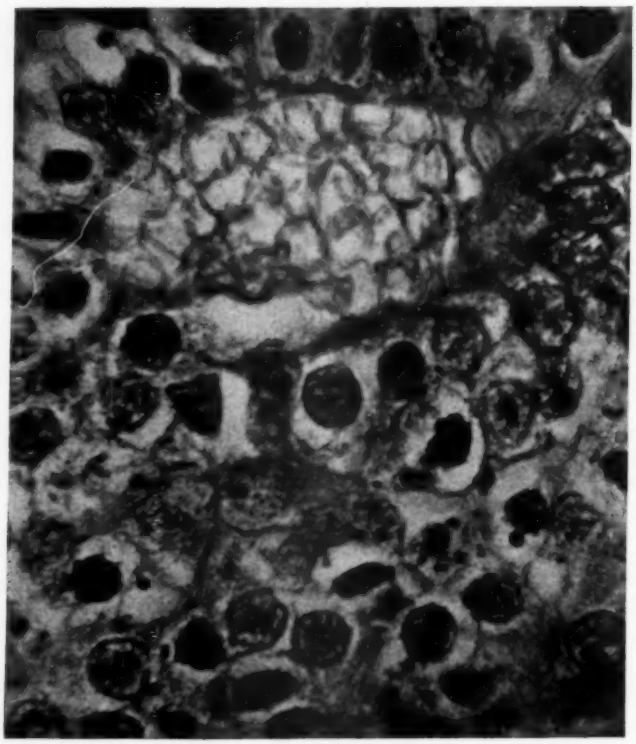


FIGURE VI. Principal cells, of varying sizes, and some with pyknotic nuclei surrounding a vascular sinus filled with red blood corpuscles. Hæmatoxylin-eosin stain. ×1,000.

Anatomical textbooks still retain the teachings of fifty years or more ago as to the detailed arrangement of the deep cervical fascia, so that it is small wonder that the majority of surgeons fail to make themselves clear in describing their approach to the parathyreoid glands, and in their search for tumours of these glands do not know exactly where to look.

In an article concerned largely with the technique of total thyreoidectomy published in THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY, July, 1940, one of us (H.R.G.P.)[1] reviewed the development of the parathyreoids based chiefly on the work of G. Louis Weller, junior,[2] and Edgar H. Norris[3] from the Carnegie Institute of Washington and on J. R. Gilmour's[4] 428 dissections of the thyreo-parathyreoid apparatus.

It was also pointed out that until Meyers and Macpherson, of Brisbane, published their description of the deep cervical fascia in *The Medical Journal of Australia* in 1938[5] there was no anatomical detail of this region which agreed with the findings of the surgeon who regularly performed a large number of thyreoidectomies.

Diagrams of the deep fascial compartments of the neck were published, and some detail was given of what we may term the subfascial thyreoidectomy, showing how the integrity of the parathyreoid glands can be ensured.

Accordingly, when the opportunity was presented of investigating a positive case of parathyreoid tumour, only slight modification of the standard thyreoidectomy operation was necessary.

FIGURE VII. A vascular sinus surrounded by principal cells, a few showing gross vesiculation of the cytoplasm approaching that seen in the *Wasserhelle* type of principal cell. Note the vesiculated chromatin network of the nuclei and the central nucleolus. Hæmatoxylin-eosin stain. Oil immersion photograph. × 1,200.

In a subsequent publication in *The Medical Journal of Australia*[6] the full detail has been described and fully illustrated, so that the actual method of approach to the thyreoid gland will not be mentioned now.

Operation Findings.

After exposure of the thyreoid gland beneath the sterno-thyreoid fascia, a blunt dissector was used to free this fascia first from the upper pole of the gland, which was then retracted and the area of the superior parathyreoid was examined, but no abnormality was seen. Then the lateral aspect of the thyreoid was freed and the middle thyreoid vein ligated, so as to permit shelling of the gland from its fascial capsule, in order to lift up the lower pole and rotate it forward and medially by a pair of Allis forceps clipped to the true capsule of the gland.

This manœuvre tensed the deep layer of the thyreoid fascia, which was then incised, this incision exposing the inferior thyreoid artery much in the fashion mentioned by A. J. Walton[7] in one of his cases.

Retraction of the fascia and a little dissection exposed a rounded tumour which was readily dislocated forwards, a small artery some 2·0 centimetres in length coming from the main trunk of the inferior thyreoid artery being revealed. Two or three small veins ran downwards towards the inferior thyreoid veins. These vessels were all included in a silk ligature and the tumour was lifted out of its bed. Unfortunately the details of the vascular connexions do not show in the photographs.

Search was made for any further tumour below the one removed and also on the left side in the regions of both the superior and the inferior parathyreoids, but no abnormality was seen.

The wound was not drained as it was perfectly dry and was closed by a stitch through the anterior borders of the infrahyoid muscles, then deep fascia and the skin.

Convalescence was uneventful from the surgical point of view.

Acknowledgements.

We are indebted to the Director-General of Medical Services for permission to publish this paper.

Appreciation is also expressed for the advice and help of Lieutenant-Colonel Lorimer Dods (officer commanding the medical division of an Australian base hospital), Major L. Utz (consultant pathologist), Major V. Rudd (pathologist), Major F. S. Hansman (consultant biochemist), of the same base hospital, and Dr. F. B. Byrom, of the University of Sydney. We are grateful to Sergeant J. E. Mondy, who was responsible for the histological work, and to Sergeant J. W. Brain for the photography, the photomicrography and the graphs.

References.

[1] Hugh R. G. Poate: "Indications for, Technique of, and Results of, Total Thyreoidectomy", THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY, Volume x, July, 1940, page 48.

[2] G. Louis Weller: "The Development of the Thyroid, Parathyroid and Thymus Glands in Man", Carnegie Institute of Washington, Volume xxiv, 1933, Number 141, page 95.

[3] Edgar H. Norris: "Contributions to Embryology", Carnegie Institute of Washington, Volume xxvi, 1937, Number 159, page 249.

[4] J. R. Gilmour: "The Normal Histology of the Parathyroid Glands", *The Journal of Pathology and Bacteriology*, Volume xlviii, Number 1, January, 1939.

[5] E. S. Meyers and R. K. Macpherson: "Arrangements of Deep Cervical Fascia", *The Medical Journal of Australia*, November 12, 1938, page 813.

[6] Hugh R. G. Poate: "The Technique of Subfascial Thyreoidectomy", *The Medical Journal of Australia*, September 20, 1941, page 318.

[7] A. J. Walton: "Surgical Treatment of Parathyroid Tumours", *The British Journal of Surgery*, Volume xix, October, 1931, page 285.

[8] D. Hunter: "Hyperparathyroidism: Generalized Osteitis Fibrosa", *The British Journal of Surgery*, Volume xix, 1931-1932, page 203.

[9] K. B. Noad and I. D. Miller: "Renal Lithiasis and Hyperparathyreoidism", THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY, Volume x, 1940-1941, page 198.

[10] T. W. Mimpriss and R. W. Butler: "A Case of Hyperparathyroidism with Unusual Features", *The British Journal of Surgery*, Volume xxi, 1933-1934, page 500.

[11] G. Gordon Taylor and R. S. Handley: "An Unusual Case of Hyperparathyroidism: Anterior Mediastinal Parathyroid Tumour Removed by Trans-Sternal Approach", *The British Journal of Surgery*, 1937-1938, page 6.

[12] B. Castleman and T. B. Mallory: "The Pathology of Parathyroid Gland in Hyperparathyroidism", *The American Journal of Pathology*, Volume xi, 1935, page 1.

[13] W. A. Oliver: "Acute Hyperparathyroidism", *The Lancet*, Volume ii, 1939, page 240.

[14] F. Albright, P. C. Baird, O. Cope and E. Bloomberg: "Studies on Physiology of Parathyroid Glands; Renal Complications of Hyperparathyroidism", *The American Journal of the Medical Sciences*, Volume clxxxvii, 1934, page 49.

EXTENSIVE AIRSCREW INJURIES OF THE SKULL AND BRAIN WITH RECOVERY OF THE PATIENT.[1]

By THOMAS F. ROSE,
Major, Australian Army Medical Corps.

A REVOLVING airscrew is one of the most lethal of weapons when it comes into contact with the human frame. The merest flick of its tip will cause severe trauma to the part involved. This happened to a man who had the dorsum of his forearm touched so lightly that the skin was not even punctured. Nevertheless, there was a subcutaneous extravasation of blood from the wrist to the elbow and a large muscle hernia was protruding through a rent in the deep fascia. The dorsal interosseous nerve was paralysed and did not recover for eight weeks. In contrast to this, the usual result of walking into a revolving airscrew is a quick death from the appalling injuries received. Recovery may ensue, however, as in the case of a patient reported by Hawkins and Wooler.[5] This man recovered after the blade had amputated his right arm, performed a thoracotomy and a laminectomy with exposure of the cord.

The case report here presented is that of an eighteen-year-old member of the Women's Australian Auxiliary Air Force, who unwittingly walked into a revolving airscrew and sustained extensive injuries to the brain and skull.

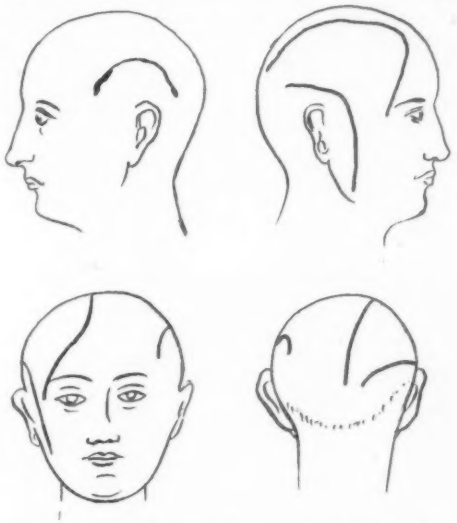


FIGURE I. The surface extent of the head wounds.

Clinical History.

This girl was struck three times on the head by a rapidly revolving propeller. As she fell, she instinctively raised her right hand to protect her head and the blade promptly amputated the index finger.

She was immediately removed to hospital, where it was seen that she was so deeply unconscious that there was no response to painful stimuli. Her pupils were small and equal, and reacted sluggishly to light. There was a general flaccid paralysis of all limbs with loss of tendon reflexes. There was a bilateral Babinski response. The breathing was slow and stertorous, the pulse rate was 90 per minute, the systolic blood pressure was 90 and the diastolic 60 millimetres of mercury.

As active bleeding had ceased, the wounds were not examined until four hours later, when by her condition she was judged ready for operation, the systolic blood pressure now being 100 and the diastolic pressure 70 millimetres of mercury. The pulse was regular at 90 per minute. Though still deeply unconscious, she now responded to painful stimuli by moaning and moving her head so that a little intravenously administered "Pentothal" was necessary for operation.

Examination showed that the propeller blade had caused three extensive wounds of the head, two on the right side resulting in open lacerations of the brain, and one on the left side involving the scalp and the outer table of the skull only. The surface extent of these wounds is depicted diagrammatically in Figure I. There was a large compound depressed fracture of the skull bounded posteriorly by a narrow depressed gutter fracture running through the parietal and squamous temporal bones, and anteriorly by a wide depressed gutter fracture which ran through the parietal and frontal bones into the orbital cavity separating the fronto-zygomatic suture. Between

[1] Accepted for publication on February 26, 1945.

these two gutter fractures the skull was comminuted and deeply depressed, but the fragments were still held together by pericranium. The extent of this bony damage may be seen in Figures II, III and IV, which are radiographs taken twelve months after the accident. Fortunately the frontal sinuses were small, so that they were not involved in the frontal fracture. The brain beneath this area of depressed bone, namely, the supero-lateral surfaces of the right frontal, parietal and temporal lobes,

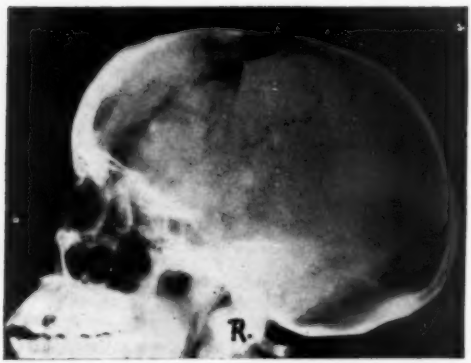


FIGURE II. Radiograph of the right side of the skull, taken twelve months after injury, showing the wide anterior gutter fracture of the frontal and parietal bones with the large area of originally depressed skull behind it.

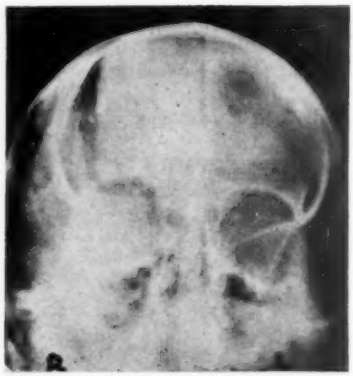


FIGURE III. Antero-posterior radiograph of the skull, taken twelve months after the injury, showing the extent of involvement of the frontal bone with separation of the fronto-zygomatic suture.

FIGURE IV. Postero-anterior radiograph of the skull, taken twelve months after injury, showing the extent of the anterior gutter fracture.

was extensively lacerated with pieces of bone and hair driven into the superficial surface.

In addition, the posterior wound had caused a compound depressed fracture of the zygomatic arch and a superficial laceration of the face. The anterior wound finished up in the orbital cavity, which was the seat of a large hæmatoma. The globe appeared to be uninjured, though later it became clear that the posterior pole had been severely contused.

On the left side the propeller had raised a flap of scalp and outer table of skull from the parietal region.

The skin and scalp wounds were cleanly divided and the edges were not even bruised. The bone edges were jagged and comminuted. The *dura mater* was torn and lacerated, and much of it was missing. The exposed brain was bruised and pulped. There was much hair contaminating the exposed tissues. All active bleeding had ceased and there was no escape of cerebro-spinal fluid from the wounds, showing that the ventricles had not been entered.

Operative Technique.—As the wounds were clean and only four hours old, they were treated as conservatively as possible. They were cleansed with saline solution and all ground-in hair was removed. No skin or scalp tissue required excision. Loose pieces of bone only were removed from the fracture edges and the large depressed area was elevated. Especial care was taken in the frontal region, as the extent of the frontal sinus was unknown. The lacerated edges of the dura were trimmed and much dura was seen to be missing. Pieces of bone were picked out of the brain, and pulped brain tissue was gently sucked out with the hand sucker. No excessive bleeding was encountered. The zygomatic arch was elevated and the widely separated fronto-zygomatic suture was manipulated together. It was impossible to suture the dura, as the edges could not be apposed. The scalp was sutured in two layers, fine cotton being used for the galea and nylon for the skin. On the

left side the flap was cleansed with saline solution, replaced and sutured in the same manner. The wounds were not drained.

Immediate Post-Operative Course.—The patient was unconscious for eight days following operation, during which time the wounds healed rapidly. A left hemiplegia was seen to be present, but this gradually disappeared as consciousness returned in the second week. At first stuporose and drowsy, the patient recovered her full mental powers by the fourth week. She was then fully conscious, bright and mentally alert, and there was no evidence of any speech defect. She had complete amnesia for the accident and the two weeks following it, but there was no anterograde amnesia. Her only complaint was that there was a large brown spot floating in the centre of the field of vision of the right eye, the sight of which was also blurred. Examination disclosed that she had lost the macular vision of the right eye owing to scarring of the macula with pigmentary changes. The visual acuity of this eye was only $^{6}/_{60}$ as compared with $^{6}/_{6}$ in the left eye. This visual defect was due to the contusion of the posterior pole of the eye.

FIGURE V. A photograph of the patient, taken seven months after injury, showing the extent of the wounds of the face and forehead.

Twelve Months' Follow-Up.—The patient had not been able to continue her work in the Air Force, as it required good macular vision. She had therefore gone back to her previous profession of teaching. She stated that she had been very well, with no headaches, giddiness or convulsions. She was rapidly adapting herself to her defective vision, and no longer noticed the loss of her finger.

In order to ascertain if there was any post-traumatic personality deterioration, her mother was asked to compare her present mental state with that before the accident. She stated that her daughter's personality and character had undergone no change whatever. She was just as energetic, vivacious and ambitious as before the accident. She was as emotionally stable as before, and her intellectual abilities were not in the least impaired. She was able to read with concentration and to write normally. She was not forgetful and there was no apathy or depression.

Physical examination showed that her wounds had healed well and the loss of bone was made up by the usual tough membrane. There were no abnormal neurological findings, and the right eye was in the same state as before. A photograph taken seven months after the accident is reproduced here (Figure V), showing that, except for the presence of the facial and forehead scars, her appearance is normal. These scars have since become less noticeable.

Discussion.

The interesting fact about this patient is the completness of the functional recovery of the central nervous system in spite of the severity and widespread nature of the cortical damage.

In the literature on open injuries of the brain it is universally stressed that patients arriving in coma should not be operated upon, as their prognosis is hopeless.[4][6] These comments, however, refer to patients with gunshot wounds of the head. If they are unconscious, it usually means that injury to the contents of the posterior fossa has been sustained[2] and they will die. Gunshot wounds of the frontal and parietal cortex

alone do not produce unconsciousness.[7] In the case here recorded, however, the unconscious state was undoubtedly due to the severe method of damaging the right cerebral hemisphere, there being no evidence of damage to the posterior fossa contents. Thus, in a similar type of injury, the absence of consciousness should not stop one from operating.

Much has been written as to the cause of personality changes or the occurrence of post-traumatic syndromes after head injuries. O'Connell[9] states that a previous good psychological background will prevent many of these disturbances. Palmer[10] attempted to correlate the force of the blow, the length of the period of unconsciousness, and the severity of the after-effects, but other writers[11][12] state that there is no relationship between these factors.

In discussing post-traumatic personality changes, it seems to me that more attention should be paid to the area injured. This patient was found to be naturally right-handed, and it is agreed[14] that the left side of the brain is far more important than the right in right-handed individuals, especially in regard to speech functions, which depend on the perfect functional coordination of the left frontal, parietal and temporal lobes. This area of brain in right-handed individuals may be regarded as the "seat of intelligence", and injury to it will bring about intellectual deterioration, various forms of aphasia and personality changes. In this patient the important left side of the brain was uninjured. It is probable that had this injury occurred to this girl's left cerebral hemisphere, or had she been left-handed, in which case the injured side would have been the more important one, the outcome would have been very different.

The absence of headaches is very gratifying, and Woltman[13] observed that headaches were more common among those in whom the period of unconsciousness was less than twenty-four hours.

Prognosis.

As personality changes have not occurred in the twelve months after the accident, it is safe to say that she will not now develop them. Her eye condition will neither improve nor deteriorate. The only doubtful factor is the likelihood of the onset of convulsive seizures. Merritt[8] states that the more severe the injury, the greater the likelihood that seizures will develop, especially if the dura has been penetrated, in which case the incidence is said to rise to 50%.[2] In addition, Ascroft[1] states that epilepsy more often occurs in wounds of the sensori-motor area. However, he adds a word of hope, stating that, although convulsions may occur at any time up to twenty years after injury, they start more often in the first two weeks after injury and thereafter their liability to develop progressively diminishes. Possibly the fact that all the damage has occurred to the girl's right hemisphere has saved her from post-traumatic epilepsy.

Summary.

The report of a patient with severe airscrew injuries to the brain and skull is presented.

Though she suffered from extensive open lacerations of the right frontal, temporal and parietal lobes, perfect functional recovery of the central nervous system ensued, save for an evanescent left hemiplegia.

It is thought that this good result occurred because the injury involved the right cerebral hemisphere in a right-handed patient in whom the left cerebral hemisphere is the more important for the higher functions.

The twelve months' follow-up is given and her prognosis is discussed.

Acknowledgements.

I wish to acknowledge with thanks the permission of the Director-General of Medical Services, Australian Military Forces, Major-General S. Roy Burston, and the Director-General of Medical Services, Royal Australian Air Force, Air Vice-Marshal T. E. V. Hurley, for permission to publish this report.

I also wish to thank Dr. W. Godby, of Perth, for the radiographs published here, Dr. Arndt, of Perth, for his report on the ocular condition, and Sergeant Lawton, radiographer, Australian Army Medical Corps, for his technical work in preparing the photograph and radiographs for reproduction.

References.

[1] P. B. Ascroft: "Traumatic Epilepsy after Gunshot Wounds of the Head", *British Medical Journal*, May 17, 1941, page 739.

[2] H. Cairns: "Gunshot Wounds of the Head in 1940", *The Journal of the Royal Army Medical Corps*, Volume lxxvi, January, 1941, page 12.

[3] D. Curran and E. Guttman: "Psychological Medicine", 1943, page 174.

[4] N. Guleke: "Suturing of Fresh Cerebral Gunshot Wounds", *Deutscher Militärarzt*, Volume vi, January, 1941, page 1, cited by Merritt,[7] page 74.

[5] J. Hawkins and G. Wooler: "Extensive Airscrew Injuries", *The Lancet*, July 4, 1942, page 8.

[6] T. de Martel: "Craniocerebral Injuries in Military Surgery", *Mémoires de l'académies de chirurgie*, Volume lxvi, June 5 and 26, 1940, page 612.

[7] H. H. Merritt: "Head Injury", *War Medicine*, Volume iv, Number 1, July, 1943, page 75.

[8] H. H. Merritt: "Head Injury", *War Medicine*, Volume iv, August, 1943, page 204.

[9] J. E. A. O'Connell: "A Group of Head Injuries", *The Lancet*, December 13, 1941, page 719.

[10] H. A. Palmer: "Mental Sequelæ of Head Injury", *Journal of Mental Science*, Volume lxxxvii, July, 1941, page 370, cited by Merritt.[8]

[11] H. Theato: "Statistical Study of the Course of Simple Concussion in 279 Cases in the Building Industry", *Der Nervenarzt*, Volume xiii, June, 1940, page 241, cited by Merritt,[8] page 208.

[12] L. N. Vishnevskaya: Quoted by Merritt,[8] page 205.

[13] H. W. Woltman: "Late Neurological Complications of Injury to the Nervous System", *Wisconsin Medical Journal*, Volume xli, May, 1942, page 385, cited by Merritt,[8] page 210.

[14] S. Wright: "Applied Physiology", Seventh Edition, 1940, page 120.

Surgery in Other Countries.

[In this column will be published short résumés of articles likely to be of practical value from Journals published in other countries and not readily accessible to surgeons in Australia and New Zealand.]

CONSERVATISM IN THE TREATMENT OF ACUTE OSTEOMYELITIS OF THE LONG BONES.

Lauber (Marburg): *"Konservatismus in der Behandlung der akuten Osteomyelitis der Langen Röhrenknochen"*, *Der Chirurg*, September 15, 1943, page 540.

THIS article appears to be incorrectly entitled, since its main content concerns the removal of sequestra in chronic cases. It refers back, however, to an article of the same title, written by Dr. Bugyi in *Der Chirurg* in 1942. In this article Dr. Bugyi set out both for acute and chronic osteomyelitis a point of view which had already been advocated for the last twenty-five years by Klapp's school at Marburg. In the treatment of osteomyelitis in all stages the least possible interference is to be aimed at. The object is simply to open abscesses and then to wait until sequestra have to be dealt with.

Bugyi wrote of the "ideal" sequestrotomy, causing as little disturbance to the newly formed granulation tissue as possible. This has been carried out during the war, and sequestra have been removed with almost negligible reaction on the patient's part. The fistula in the soft tissues is dilated by means of a glove stretcher, not cut; and in many cases this gives sufficient access for the removal of the sequestrum. Should the bony cloaca have to be enlarged, this is done by chisel at one point only, and in as small a degree as is possible.

"Guttering" of the bone, which is still often advocated, should be avoided. In its performance the protective granulations are removed, infection is carried more deeply into the bone, and fresh sequestra may form, or even pathological fracture may occur. The guttering technique has no good cosmetic results to recommend it, even when a muscle flap is implanted into the gutter, and after guttering, months are required for healing, whereas when the sequestrotomy has been done with a minimum of damage, healing is often surprisingly rapid.

ARTHUR E. BROWN.

VOLUNTARY SUBLUXATION OF THE HIP IN CHILDREN.

E. Heidsieck (Breslau): *Zeitschrift für Orthopädie*, Volume lxxiv, 1943.

THERE are two conditions occurring in the hip joint in children which are very similar on clinical examination. One is the "snapping" hip, in which a muscular or fascial band snaps across the great trochanter on certain movements. The other is the true voluntary subluxation, in which the child can by a deliberate movement cause the head of the femur to leave the acetabulum.

Heidsieck refers to cases of the voluntary subluxation type reported by Ombrédanne and Hilgenreiner as occurring in children aged from eleven months to thirteen years. He himself reported in 1939 a case in a girl five years of age, and in this article he describes another in a child twenty-six months old. All were female children.

The patient whose history is now reported was of normal health and development, except for a certain slackness of the musculature. The child had the ability to dislocate her right hip by movements of flexion and contraction, which were so well defined that the action of the muscles taking part could be recognized. By strong action of the adductors and *tensor fasciæ latæ* the thigh was flexed and the femoral head thus pressed against the posterior wall of the capsule. By means of further contraction of the combined longitudinal muscles of the thigh in the assumed position of flexion, adduction and inward rotation, the head of the femur was further pressed strongly against the capsule until it slipped with a palpable grating over the edge of the acetabulum. A moment later, when the muscles relaxed, it slipped back again, and its passage back into the acetabulum was accompanied by a grating which was not only palpable but clearly audible. No pain accompanied these movements.

The child's mother first noticed this performance when the infant was only a month or two old, in association with an attack of urinary infection. She got the impression that the child did it when cross or uncomfortable. A traumatic origin at any

time could definitely be excluded. The subluxation occurred only at the child's own volition, and is therefore not in the class of "habitual" subluxations.

On X-ray examination the appearance of the joint was entirely normal. The head of the femur and the acetabulum were normally formed, and the ossification centres were equal on the two sides. An X-ray film was successfully taken at the moment of dislocation. The main points revealed by it were a displacement of the head of the femur laterally, but not upwards, and a "lighting up" of the joint cavity in a manner compatible only with the presence of gas in the joint. Through this lighted space the shadow of the *ligamentum teres* could be seen passing between the head of the femur and the acetabulum. Owing to this gas filling it was possible to see that not only the bony but also the cartilaginous margins of the joint cavity were quite normally formed. This appearance of gas in the joint was demonstrated in both of Heidsieck's cases and also in Hilgenreiner's second case. It is explainable by the effect of a suddenly created vacuum in the cavity causing the liberation of gases held in solution in the capsule and synovia.

The determining factor in the production of the condition described would seem to be a slackening in tension of the joint capsule. Other joints can sometimes be found to be "loose". In the case here described overstretching was easily demonstrable in the joints of the hands and fingers, and this essentially predisposing factor is probably truly congenital. The condition has nothing in common with those cases in adults which follow on trauma. For treatment all that is necessary is to limit flexion and adduction movements, especially during the night hours. A simple night plaster case has proved quite sufficient in practice.

ARTHUR E. BROWN.

THE CONSERVATIVE TREATMENT OF IMPERMEABLE ŒSOPHAGEAL STRICTURE.

R. Felkel (Prague): *"Zur konservativen Behandlung röhrenförmiger, impermeabler Narbenstrikturen der Speiseröhre"*, *Der Chirurg*, September 15, 1943, page 550.

IMPERMEABLE œsophageal stricture not only presents the surgeon with unusual difficulty in the initial steps of the treatment, but makes demands on his skill and patience more than almost any other malady. The case here reported illustrates this fact, and also shows what can be achieved in the most unfavourable circumstances.

A young man, twenty-two years of age, swallowed by accident a mouthful of caustic soda. On admission his mouth and his œsophagus were severely corroded, and after twelve days he was started with dilatation treatment. At that stage it was possible to find and enter the stricture without difficulty, but it was not possible to dilate it to a width greater than 3·5 millimetres. The patient, however, was able to swallow fluids and semisolids, and insisted on discontinuing the treatment. Two months later, starving, exhausted and penitent, he sought readmission to hospital. A Witzel type gastrostomy was performed, and the ensuing weeks were spent in building up the patient's strength, while fruitless endeavours were made to pass a sound of any sort through the stricture from either end. Radiographic examination showed that no fluid whatever passed through the stricture, which extended from the bifurcation of the trachea to the diaphragm. The patient's condition having satisfactorily improved, it was decided to attempt to pass an "electrolytic" sound, after the method of Jenkel, as the literature on this method, though scanty, claimed great possibilities of success.

An œsophagoscope having been passed down, the internal electrode was inserted under vision into the funnel of the stricture. It was gently pressed downward, while a galvanic current of three to five milliamperes was sent through it. After some four minutes the electrode was found to have gone down about two to three centimetres into the stricture, and it was not possible to get it to go further. It was then removed, and a filiform bougie was inserted under vision into its track. This bougie passed on into the stomach, where its lower end was picked up by cystoscopic instruments used with a cystoscope. A double silk thread was thus successfully brought from stomach to mouth, and dilatation of the stricture up to three millimetres was achieved without difficulty.

An attempt to go beyond this point brought a relapse. The patient, who had regained the power of swallowing fluids, lost it and developed fever and pain in the back, which radiated widely. The thread was removed and calcium and "Prontosil" were administered, whereupon the temperature subsided. On the resumption of treatment, only a very fine bougie would pass the obstruction. The electrolytic sound was passed through and was slowly withdrawn with the current passing. Following this procedure immediate results were obtained, and within ten days a four-millimetre bougie could be passed. Further patient endeavour succeeded eventually in the passage of a bougie of nine millimetres, and this was left in place for twelve hours.

Several times during this period the passage of bougies had been followed by fever and pain, and this last passage of the nine-millimetre instrument produced a more serious reaction than usual, with widely radiating pain, leaving finally an intolerable aching in the right ischial region, which immobilized the patient for six weeks. The conclusion from these accidents was that undue damage was being caused to the lining of the passage and that this must be avoided. The patient, on the resumption of treatment, could still swallow saliva, and a fine bougie would pass through the stricture. He was trained himself to pass a ureteric catheter, the end of which was picked up in the stomach. Into the funnel end of this the tapering tip of the bougie is inserted and fixed by means of a smooth-surfaced strip of strapping. This can then be drawn through the stricture with less trauma than is caused by the use of a thread and tie. It was found by experience that bougies were much more easily passed upward from the stomach, rather than downward from the mouth, and in later treatments the ureteric catheter was passed upward, by means of the silk thread. The bougies should be softened before use with soap and warm water, and laid in spirit or some other suitable antiseptic before their passage. The whole operation should be carried out with gentleness and great aseptic care. The patient should have nothing by mouth for twelve hours before; and a careful mouth toilet is essential. If the passage is accompanied with much difficulty, light "Evipan" anæsthesia is useful; and the task is often made easier if the patient swallows some liquid paraffin just before the bougie is passed. Not more than one-half size extra diameter should be aimed at in a week. In approximately ten weeks the patient here reported would tolerate a nine-millimetre bougie without febrile reaction, and he now passes a ten-millimetre bougie daily.

The treatment may take a year or more, but this is certainly no longer than is required for successful operative treatment. No one should underrate the dangers associated with the conservative methods; they can with care be reduced so that they are made very slight in comparison with active surgery. Open operation should be considered advisable only when the stricture fulfils all the requirements which designate it as permanently impermeable. These are that neither contrast medium nor dyes can penetrate, and the electrolytic sound cannot be introduced into the stricture even from the stomach end.

ARTHUR E. BROWN.

TREATMENT OF "RAISED HUMERUS".

M. Saegesser (Berne): "*Die Behandlung des Humerushochstandes*", *Der Chirurg*, September 15, 1943, page 549.

STIFFENING following prolonged complete immobilization of the shoulder joint generally causes the humerus to assume a position higher than its normal position. As a result of this the acromial process forms a barrier to full abduction of the shoulder, since the greater humeral tuberosity impinges on it in the new position. Saegesser attacks this condition by the removal of a curved portion from the end of the acromial process, giving the tuberosity room for its full movement.

The operation is carried out under full anæsthesia, with the patient lying prone and the affected arm hanging vertically from the table. The incision passes in an antero-posterior direction across the acromial tip. The periosteum is split, and with its attached deltoid fibres is pushed distally. The bone resection is then done. Should this not produce full range of movement, it may be necessary in addition to perform a Z-tenotomy in the *pectoralis major* tendon.

As soon as full abduction is attained, the arm is fixed in this position by a plaster bandage, affixing the arm to the top of the head. This must be worn for two weeks and is then replaced by a "cap-bandage". Daily movements are carried out, and when active abduction reaches 140° the retaining appliance need be worn only at night.

This little operation gives good results when the obstructing mechanism has been operative over long periods. In one case reported, the abduction had been limited to 80° for over two years and had resisted all other methods attempted to relieve it. In a second the history extended over more than twelve months. The operation requires only that the patient be reasonably young, say, not over fifty-five years old. In both the cases reported the result has been fully maintained for more than two years after the operation.

ARTHUR E. BROWN.

Reviews.

The Student's Pocket Prescriber and Guide to Prescription Writing. By DAVID M. MACDONALD, M.D., D.P.H., F.R.C.P.E.; 1945. Edinburgh: E. and S. Livingstone. 4″ × 2¾″, pp. 356. Price: 4s.

THIS little book should be a help to students who are sitting for their final examinations in medicine. It contains much that is useful in the way of the form and practice of prescribing, dose tables, and a number of prescriptions relating to and indexed under regions and diseases for which they should be used. Much of the book is of historical value only, and the student fortunately is seldom in a position to need a pocket prescriber.

Pye's Surgical Handicraft. Edited by HAMILTON BAILEY, F.R.C.S.; Fourteenth Edition; 1944. Bristol: John Wright and Sons, Limited. 9″ × 5½″, pp. 638, with 724 illustrations. Price: 25s. net.

SINCE the publication of the first edition of this famous manual by Walter Pye in 1884, many thousands of medical men must have found it an invaluable pilot and guide through the mysteries and difficulties of the first clinical months of their training and in the earlier days of general practice. Mr. Hamilton Bailey, under whose editorship editions eleven to fourteen have appeared during the course of six years, is to be congratulated on the excellent standard of this last edition, produced at a time when size and material have of necessity to be curtailed. Both he and his numerous collaborating editors have produced a wealth of useful and essential practical advice, also some very good hints to the tiro on "what not to do". Many excellent illustrations are used to demonstrate methods of clinical procedure, and the range of work covered is surprisingly full.

We commend particularly the latter chapters on such subjects as "Surgical Appliances and Splints", the "Treatment of Acute Poisoning", "Medico-Legal Reports", "The Assessment of Incapacity" (in this age of medical certification), "The Relationship of the House Surgeon to his Colleagues" and "Hospital Administration", which should prove extremely useful to the newly qualified man. It is a volume which should be in the possession of all "surgical dressers, house surgeons and practitioners".

Illustrations of Bandaging and First Aid. By LOIS OAKES, S.R.N., D.N.; Third Edition; 1944. Baltimore: Williams and Wilkins Company. Edinburgh: E. and S. Livingstone. 8¼″ × 5¼″, pp. 278. Price: 6s. net.

THIS well illustrated book, consisting almost exclusively of photographs of the various stages of bandaging, is to be recommended to doctors and nurses alike as being a clear and practical and easily followed guide to the method of application of bandages and triangles to any part of the body. One section deals with first aid treatment of fractures and hæmorrhage, and the "blanketing" of a stretcher. This book exemplifies all that is best in the graphic method of teaching a subject.

The Urinary Tract: A Handbook of Roentgen Diagnosis. By H. DABNEY KERR, M.D., and CARL L. GILLIES, M.D.; 1944. Chicago: The Year Book Publishers. 8″ × 5″, pp. 320, with 109 illustrations. Price: $5.50.

THIS publication by the Professor and Associate Professor of Radiology at the State University of Iowa College of Medicine, United States of America, completes a series of handbooks of Roentgen diagnosis.

Accuracy in urological diagnosis depends largely on an ability to recognize the variations from the normal radiological configuration of the urinary tract corresponding with the various pathological conditions which may arise. Very few publications of recent years have endeavoured to cover this essential and interesting phase of urology.

The authors preface this work by stressing the importance of correlating all clinical and laboratory data with the radiological findings before a final diagnosis is made. In our experience it is the custom of radiographers, particularly in reporting on excretion urography, to attempt, far too often, to arrive at a pathological diagnosis from the pictures produced. It would be far more satisfactory if the aberrations from normality were stated, and the urologist was allowed to make the diagnosis on a consideration of his complete findings.

The authors stress the view that technical procedures should be scrupulously controlled. These include immobilization, radiographic factors, careful inspection of accessories, positioning and the taking of a sufficient number of films.

A succinct discussion of the normal and abnormal found in the various portions of the urinary tract is opposed on practically every page by a series of reproductions of the corresponding radiographs. There are in all four hundred of these reproductions and the normal and abnormal fillings by the opaque media are adequately demonstrated.

A considerable portion of the book is devoted to the radiological examination of the bladder, urethra and the prostate. This is a portion of the urinary tract the investigation of which by X rays has been neglected in the past. Accurate information concerning many pathological conditions in these regions can be obtained without the trouble and the possible dangers of cystoscopy.

An extensive bibliography completes this work, which is beautifully produced. The general set-up, the paper on which it is printed and the reproductions of films are beyond criticism. It is a book which should be in the library of every surgeon doing urological work and every radiologist.

Handbook of Practical Bacteriology. By T. J. MACKIE, C.B.E., M.D., D.P.H., and J. E. MCCARTNEY, M.D., D.Sc.; Seventh Edition; 1945. Edinburgh: E. and S. Livingstone. Pp. 728. Price: 17s. 6d.

THIS is the second wartime edition of this very useful book designed primarily for the diagnostic bacteriologist, laboratory technician and student. It also serves as a valuable reference book for medical practitioners for whom bacteriology assumes greater importance in this era of chemotherapeutic drugs.

The main additions include references in the text to antibiotic substances, of which the chief is penicillin, and an enlarged appendix. In this a brief review of antibiotic substances produced by fungi and bacteria is included. The methods for testing the sensitivity of bacteria to sulphonamide compounds and to penicillin by the gutter plate method as used by Fleming are described. Also details for the determination of the bacteriostatic action of the blood during penicillin treatment are given.

The addition of penicillin to the media as a selective agent in the isolation of *Bacillus pertussis* is suggested.

A small section on anaerobes gives practical information regarding the collection of cultures from wounds and identification of the organisms. The addition of potassium tellurite to the medium or the use of 6% agar is suggested for the suppression of that bugbear of the bacteriologist, *Bacillus proteus*.

The formula of Field's stain and the method of application for the staining of malarial parasites, the diagnosis of glandular fever by Paul and Bunnell's test and the Kahn verification are now included.

The subject matter is clearly set out in good print, and with these recent additions admirably fulfils practically all the requirements of diagnostic bacteriological laboratories.

Bone-Grafting in the Treatment of Fractures. By J. R. ARMSTRONG, M.D., M.Ch., F.R.C.S.; 1945. Edinburgh: E. and S. Livingstone. 9¼″ × 7″, pp. 187, with 204 illustrations. Price: 25s.

OVER the last twenty years the treatment of fractures has become increasingly exacting and now constitutes a special study, even among orthopædic surgeons. A high critical faculty is exercised and imperfect results are no longer accepted as satisfactory. Admittedly disability still arises, particularly in certain situations of especial difficulty, but these challenges are being accepted and methods are being evolved to meet those contingencies.

The rate of evolution is such that no uniform practice can be defined. One school will prefer a plaster technique, one external metallic fixation, another open operation, and so on. It becomes necessary for the fracture surgeon to be aware of all shades of opinion, and familiar with all methods which have been placed on a sound foundation. For this reason the present monograph on bone grafting will be received with interest and approval. It is by no means an exhaustive treatise, and there is little or no reference to methods, such as spongiosa and osteoperiosteal grafts, which are not advocated by the author. It is rather a record of personal opinion based on personal experience. This, of course, is not a disadvantage, since it enables the author to present an account of the subject which is concise, practical and, above all, standardized to conform with certain principles.

The formulation of these principles occupies the earlier chapters, which may be taken to comprise a first section. The author discusses the essentials of successful

grafting, the indications for such work and the different types of grafts. He concludes that onlay grafting is the method of choice in the shaft of a long bone, and that in certain other situations the buried cortical graft may be used. It is of interest that onlay grafting is recommended even in the treatment of some recent fractures, if for certain reasons an open reduction has been decided upon.

The chapters concerned with onlay grafting constitute a second section. They are particularly well done and will stimulate interest in this comparatively new development of bone surgery. The various regions are taken in turn and appropriate technique is described in full detail. The clarity of the text is enhanced by the excellent illustrations, so that a valuable work of reference is provided in this field of surgery.

Not less interesting are those chapters, comprising a third section, which deal with the use of small and massive buried grafts. The author describes ingenious personal contributions in connexion with fractures of the scaphoid and *os calcis*.

Finally, tables are appended, setting out the number and nature of the cases upon which the monograph is based.

In a book of this sort, written so much from personal experience, it is hardly to be expected that grounds for controversy could not be selected. Some surgeons may prefer other methods of treatment or other methods of grafting. It will be admitted that the onlay graft is highly efficient. However, it is clear that a particularly extensive exposure of the fracture is needed, together with an operation on an intact tibia. Many cases are found in which much more simple procedures are entirely satisfactory, not only with recent fractures, but also in non-union. Some surgeons may prefer to retain these methods in such cases, while adopting an onlay graft in others. It appears also that the pre-operative treatment includes what amounts practically to eight skin preparations in four days. Surely there is nothing to be gained from more than an efficient double preparation unless it be a chemical dermatitis.

In conclusion, this book is heartily recommended to the orthopædic specialist.

Pulmonary Tuberculosis: A Handbook for Students and Practitioners. By R. Y. KEERS, M.D., F.R.F.P.S., and B. G. RIGDEN, M.R.C.S., L.R.C.P., with a Foreword by F. H. YOUNG, O.B.E., M.D., F.R.C.P., D.P.H.; 1945. Edinburgh: E. and S. Livingstone. 7½″ × 4¾″, pp. 285, with many illustrations. Price: 17s. 6d. in Great Britain.

THE aim of this handbook, according to the authors' preface, is to outline clearly, for the student and busy practitioner, the essential facts concerning pulmonary tuberculosis. This objective has been most successfully achieved. There is probably no better handbook available at present, which deals with the subject so adequately and with such discrimination. Generally, its matter conforms with the most authoritative up-to-date opinions. It is written in simple and clear language, which makes the book very easy to read.

The authors, as mentioned in the foreword, have both been patients with tuberculosis. Their comprehension of the patient's point of view has undoubtedly enriched the section dealing with treatment. Though over one-third of this little book is concerned with treatment, all aspects of interest to the student and practitioner are covered.

The only criticisms one might make are in points of minor detail. It would appear unlikely, for example, that the phagocytic cells, which appear at the site of infection, even in part, are "derived from the alveolar epithelium". As pointed out by Rich, they are identical with the monocytes or transitional cells of the blood and with clasmatocytes or histiocytes of the tissues.

The authors state that once caseation has occurred, "the possibility of absorption of that particular focus no longer exists". There is, however, ample experimental evidence that complete resolution of caseous material may occur. Infection by the intestinal route is very much less in Victoria than the 15% to 25% quoted in the book. The explanation given as to the ætiology of epituberculosis as an extensive perifocal reaction cannot be regarded as satisfactory. This condition, as Rich and others believe, is a resolving tuberculous pneumonia. As the authors and Rich point out, somewhat similar radiological appearances may be seen in atelectasis caused by pressure on a bronchus by a tuberculous gland.

The authors believe that "endogenous exacerbation is certainly the most common origin of all cases of isolated tuberculosis". Terplan's more recent work, some of it published since this book appeared, produces strong evidence of the exogenous origin of many reinfection lesions. Further, one meets clinically with cases in which such exogenous reinfection can reasonably be presumed. The authors, in discussing the disintegration of the bacilli in the tissues, express the opinion that "they may liberate toxins". Further, they attribute the general symptoms to the liberation of toxins.

Rich, however, has affirmed that "as far as it is known at present, this bacillus produces neither an exotoxin nor an endotoxin of any appreciable potency". Effects attributed to toxins may be explained by the phenomenon of hypersensitivity. These effects do not occur in a normal body, only after the development of hypersensitivity. The authors, in discussing the question of immunity, are careful to indicate that allergy implies an altered state and not necessarily hypersensitivity. Nevertheless, the use of the term allergy in connexion with immunity may be confusing, as to many it connotes hypersensitivity, and it is now clearly established that hypersensitivity is not essential for the development or maintenance of acquired resistance.

In the section dealing with the incidence of infection, the statement that "economic factors do not appear to influence incidence rates" would not be generally accepted and is not in conformity with American investigations. Economic factors profoundly influence morbidity and the incidence of infection is much higher among contacts than in the general population.

Reference to the variations of the blood sedimentation rate with the room temperature might well have been made, as these variations may give rise to misleading results. Ideally, the test should always be carried out under constant temperature conditions.

To the essential requirements of a modern sanatorium facilities for educational and vocational training might have been added. The need for adequate bed rest is well stressed. It is very satisfactory to read in a British textbook, after early graduated exercise has been advocated in Britain for years, that "until the lesion has healed or until it is obvious that complete healing is unobtainable, exercise has no place in the routine of treatment". The criteria for the assessment of a patient's fitness for exercise are very soundly dealt with. It is certainly not always true that "gradual obliteration of a pneumothorax space once begun cannot be prevented". Such obliteration may be checked by a "blockade" with oil, almost the only indication left for the use of oleothorax. Extrafascial mobilization, as introduced by Semb, to supplement thoracoplasty, is not always indicated, as suggested by the authors. In many cases satisfactory cavity closure is achieved without such mobilization. In some instances, in fact, the mobilization through allowing the apex to drop considerably will not bring about cavity closure. In tension cavities more than three centimetres in diameter, closed suction drainage prior to thoracoplasty is more likely to bring about healing, a use of Monaldi's method not specifically mentioned by the authors. There is also no mention of the use of suction, through a needle in the chest, in tension pneumothorax. It is commendable that the authors should stress the fact that "there are few cases of advanced pulmonary tuberculosis, which at one stage were not amenable to collapse".

The authors' views on pregnancy in tuberculosis and on after-care are very sound. Their appeal for an improvement in the teaching of tuberculosis is especially applicable to Australia.

An outstanding feature of the book is the excellent reproduction of X-ray films, each film being accompanied by a most helpful explanatory line drawing. The interpretation of these films is further facilitated for the student by the provision of a book-mark, on both sides of which the X-ray image of a normal chest is reproduced.

In spite of war conditions, the book is very well produced and is worthy of the well-known firm by which it is published. It can be confidently recommended to students and practitioners, and deserves wide circulation.

The Neurosurgical Patient: His Problems of Diagnosis and Care. By CARL W. RAND; 1944. Springfield, Illinois: Charles C. Thomas. 8″ × 5½″, pp. 588, with 118 illustrations. Price: $4.00.

EACH of the fifty-four chapters of this book is devoted to a neurosurgical subject. All common neurosurgical conditions are included. The subjects are dealt with under four headings, namely, the spine, head injuries, the brain and miscellaneous. The titles of the first three sufficiently explain their contents. Under the last-named are found discussions on trigeminal neuralgia, phantom limb, essential hypertension, malignant exophthalmos, Raynaud's disease, Buerger's disease and others. The method of presenting each subject is by reporting an informal bedside clinic. The student, resident medical officer and teacher (the author) all take part. The result is an uneven and unordered account of the malady, so that the book is unsuited both to the student and to the general surgeon, for both of whom it is intended. We are tempted to suggest that each chapter should be put into essay form. This would provide a vehicle through which the author could convey more precisely the many important things he has to say by reason of his rich and wide experience. Developed thus, the book may form the basis of a future textbook of neurosurgery for students in this domain. The illustrations, printing and binding are excellent.